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THE DAWN OF WESTERN SCIENCE IN JAPAN

By KAN KIKUCHI

[THE following narrative is translated from a novel written by Kan Kikuchi, a well-known contemporary Japanese writer. It was originally published in Kaizo. The author took the material for this part of his story from a book entitled "The Dawn of Dutch Science," which is substantially the autobiography of a physician, named Gempaku Sugita, who lived about 150 years ago.

This narrative should not be regarded as the recital of a mere incident. It has, in fact, a much deeper significance, for it describes how the Japanese were first awakened to the superiority of Western science to the classic Chinese conception of nature. The event may be regarded historically no less important than the visit of Commodore Perry in 1853, because it marks the Japanese introduction to European science.

Only those who know the extent to which Japanese thought in the eighteenth century was dominated by Chinese theories are in a position to realize how much courage and tenacity was needed to make any headway against the prevailing scholastic conservatism.

If I take this opportunity of introducing Gempaku Sugita to American scholars it is because, as guests of that noble institution, the Rockefeller Foundation, we wish to have it known that the earliest and strongest efforts to bestow upon our people the manifold blessings of Western science were made by members of the medical profession.

This historical incident serves to prove that the eagerness for scientific development, which has been so strongly in evidence during the last fifty years, was always latent in the Japanese people, and required only a suitable opportunity to find its practical expression.

For their assistance in the translation I wish to express my indebtedness to Mr. Y. Iwanaga, to Mr. Smith, and to Mr. R. Kumasaki.—MATARO NAGAYO.]

I

It was a little after 10 o'clock when Sugita Gempaku[2] came to the house of Nagasakiya Genyemon, an innkeeper in the Honkokucho Street, Nihonbashi, Yedo. A clerk who was an old acquaintance came out and showed him into the room of Nishi Zenzaburo, the interpreter. It was somewhat of a surprise to find Mayeno Ryotaku[3] already seated there, with an air of serene composure.

Greetings with the host over, Gempaku turned towards Ryotaku and wished him a hearty "Good morning." The latter returned the greeting with a slight bend of a head covered with long glossy hair, without showing even a suspicion of a smile on his pale, pock-marked face with its high Grecian nose. This was nothing new, and yet it was not altogether pleasant to Gempaku.

Ryotaku was a physician attached to the Lord of Nakatsu. He was known for his erudition and scholarship. Gempaku held him in high esteem. In spite of all this, he could not help feeling something that chilled an enthusiastic intimacy.

He had met him several times in this selfsame place. They fell in with each other twice or thrice during the previous year while the Dutch captain was staying here. This Dutch captain had been staying here for seven days, and they had met three or four times in this short interval.

In spite of all this, something interfered with the growth of friendship. Gempaku did not hate him, did not even dislike him, but in his presence he always felt a strange oppression weighing on his mind. "Ryotaku is here," this consciousness was always on his mind; it never left him. Ryotaku's every motion, however slight, fixed his attention. Every smile, every frown, caused him an indefinable sensation. The more he tried to get rid of his irritation, the less he was able so to do.

Ryotaku, on the other hand, did not apparently heed his presence. So at least it seemed to Gempaku, and this embarrassed him all the more.

Everybody came to this inn to meet the Dutch captain, for here in Yedo (the old name for Tokyo) the official regulation regarding the association with the Dutch people was not so severe as in Nagasaki, because the captain's stay in Yedo purported to be only temporary.

Day in and day out there was a large crowd of visitors who were interested in the various branches of the Dutch sciences (med-

[2] 1730–1817.
[3] 1722–1803.

icine, medicinal plants, warenkunde, physics). Among the visitors, there were samurais, merchants and sundry others.

Noro Genjo, Shogun's doctor; Yasutomi Kiseki, medical attendant on the Lord of Yamagata; Nakagawa Jun-an, a physician of the same clan; Aono Chobei, a pawn broker living in Kuramae, who was noted for his inquisitive propensity; Hiraga Gennai, a masterless Samurai who was formerly in the service of the Lord of the Sanuki province; Hosoi Ki-an, a monk in the court service; Okubo Suiko, a scholar of Chinese classics and a few others were the usual habitués.

Questions of every imaginable kind were discussed between these men and the Dutch sailors, through the dubious intermediary of the interpreter. For the most part, the questions asked were foolish and without significance, and did not go much beyond Dutch customs and manners. They would break into laughter when the captain showed them how absolutely stupid their questions were. They would cheer and exhibit childish joy when the captain showed them interesting machines and instruments such as barometers, thermometers, electrometers and so forth.

Ryotaku never failed to preserve his supreme detachment. Never would he ask a stupid question, as the others did. From the beginning to the end, he would remain passive and silent, with a faint smile about his lips, which impressed one as strikingly sardonic. Whoever would laugh over the senseless talk, he would remain indifferent, as if he thought it a matter that little concerned him. His tight-closed lips scarce ever parted.

One thing was singular about this man Ryotaku. He would not omit to put a question or so, when silence born of fatigue reigned over the party. Often his comrades could not even grasp the drift of his question, but, strangely enough, the captain always assumed a very serious air when the interpreter completed the communication, and went into a lengthy explanation with a tremendous enthusiasm on his face. This apparently self-sanctified air of Ryotaku caused Gempaku an unaccountable irritation, though no one else ever seemed to heed it.

It happened one day, by way of an example, that the Dutch captain took out a small sack and showed it to the habitués of the room. The interpreter spoke:

"Captain Karance says he will be ready to give this to anybody who can open it."

Meantime the captain was puckering his face with laughter. There was hearty enjoyment. Hosoi Ki-an took it up, but lost temper, and threw it away when he could not open it.

"I will try it," said Yasutomi Kiseki with an important air. Soon he was at his wit's end and gave it up. The sack travelled

from one person to another. Merriment and jests increased with every failure. This immensely pleased the captain. He was beaming with cynical delight.

Now came Gempaku's turn. He took it up with a happy smile. There was a metal piece about the mouth of the sack which was in all probability the key to the whole contrivance. He tugged at it here and there without being able to loosen it at all. He smiled wryly and was going to hand it to the next one. But there was no one left but Ryotaku, to whom none thought of handing it because he was sitting so sober and grave, looking much too serious for a friendly approach.

"Will you try it, Dr. Ryotaku?" said Gempaku, and started to hand it over to him. But Ryotaku looked at it coldly and did not even deign to try it. Probably he was not quite pleased with the whole party's getting childishly interested in a worthless toy and making such a fuss about it. Or maybe he thought it above high class samurais to let a foreign captain make such fools of them. He did not pay attention to the sack when Gempaku presented it to him, and an awkward silence fell on the company.

Hiraga Gennai, a witty man, came in at the most opportune moment. He looked at the sack, picked it up and opened it without the faintest effort. Astonishment and admiration showed on each face. His sagacity spirited away the chill and brought back joy and laughter.

Something in Gempaku's heart, pride or antipathy or whatever it was, commenced to assume a more definite form from this moment. Gempaku could not ask nearly half so many questions as he wished in Ryotaku's presence. "Ryotaku may know this already"—this thought was constantly haunting him, and he felt as if he had been creating chances to expose his ignorance before Ryotaku. Gempaku had a good amount of hollow vanity to trouble him at heart. He knew how shameful it was to feel so, but in spite of all this consciousness, he could not get rid of it. Thus a very queer, unaccountable psychology prevented him from free questioning, in spite of his burning desire to know more about Dutch civilization and especially about Dutch medical science.

On this very day, he had wished to see the interpreter alone before Ryotaku put in an appearance. He had wished to ascertain from Zenzaburo, the interpreter, whether it was at all possible to learn the Dutch language. So, the next day when he came half an hour earlier and found Ryotaku already there he was quite disconcerted. But he now felt ashamed of himself for worrying so much over Ryotaku. He managed after an effort to dispel his hesitation and disclosed to the interpreter his long-cherished intention to learn Dutch.

"I want you to tell me frankly if it would be possible for me to learn the Dutch language or if it would be a futile attempt giving me only pains for my labor. Tell me frankly for my guidance what you think about it."

Gempaku's inquiry was full of warmth and sincerity. Zenzaburo was very sympathetic, as if he appreciated the inquirer's good intention and honest zeal. But his answer was in the negative. He replied in a very light-hearted manner peculiar to the southerners:

"I have been asked the selfsame question many, many times, but I have always advised people to give up the idea. It is only so much futile effort. Even among my brother interpreters, there are few who have learned to understand written Dutch. The others have managed to put down the spoken Dutch in Japanese characters, learn it by heart and use it as occasion required. For instance, if they wished to ask a Dutch captain or a sailor how to communicate their wish to drink water, they could do it in the beginning only with gestures. Hold your cup in one hand, make as if you poured into it, raise it to your lips and then look inquiringly at them. They will then tell you it is drink. So far, so good, as long as your subject matter is simple enough to admit explanation by gestures. But how could you manage if you wanted to ask the difference between a heavy and a light drinker? You can not possibly do it by a gesture. Suppose you gesticulate like a drinker. The other person will make nothing of it. Further, there are grades and varieties of drinkers. Some drink a good deal without really enjoying it. Others immensely enjoy it but will take little at a time. Such delicate shades of meaning are totally beyond the power of a mere gesture to express."

"True!" Gempaku could not help being convinced, and this made the other the more loquacious.

"Here is one instance which will show how exasperatingly difficult the comprehension of some Dutch words is. They have a word which signifies take a fancy to—aantrekken.

"I have heard this word spoken, and have used it myself ever since my infancy, as my father pursued the same profession. Now I am fifty years old and have come to know its exact meaning for the first time during my recent trip to Yedo."—He was called from Nagasaki to interpret for the Dutch mariners—" 'Aan' means the source, while 'trekken' signifies 'to draw.' So both combined come to mean 'attract to self from yonder.' 'Wine Anterecken' is the equivalent for 'wish to drink wine.' 'Home Anterecken' means 'pining for home.' If one single word implies this much you can well imagine the rest. The acquisition, however imperfect, of the whole system is difficult even for those who have kept themselves

in touch with the language from the cradle. For you who stay in Yedo without any chance of coming in contact with Dutch people, such an attempt will be nearly hopeless. Observe what little progress Noro Genjo and Aoki Bunzo have been making for all their splendid efforts along this line. My honest advice is that you give up the idea of such a fruitless task."

Zenzaburo spoke as if he thought the business beyond all hope, even for himself.

"I see your point. Quite convincing indeed!" This was the only answer Gempaku could think of under the circumstances. He could by no means dare to ask further about the best method of study, while the interpreter was so enthusiastically advising him to abandon the idea.

"We will have to give it up. What else can we do when we hear you talk so?"

Ryotaku abruptly interrupted here, for he had up to this moment been attentively listening to the conversation.

"I don't think so. Red-haired people are also human. There could not be any absolute reason why we should not be able to understand books written by fellow-humans. I don't see that this case is much different from that of the Chinese classics which we are now using daily. They were originally imported. The works of Confucius and Mencius, which form the backbone of our moral life, must have been just as difficult in the beginning as the Dutch books we are now talking about. Our ancestors must have taken great pains in elucidating them word by word before they made them their own. How many millions have been indebted to our painstaking ancestors during the 20 long centuries that have since gone by! That is what gives me courage. I am ready for what difficulties may confront us. Try it, my friend! I will go along with you. I am 49 years old and I will strive as long as Providence spares me."

Ryotaku's statement of his firm intention went direct to Gempaku's heart. He felt ashamed before such a noble ideal. Indeed, he could not help taking it as sincere advice to himself. Nonetheless, it was not altogether pleasant to be so abruptly challenged. To be frank, he had been talking like that partly as a friend, in a light-hearted manner. It was taken all too seriously by Ryotaku, who answered him in dead earnest. Gempaku was somewhat disconcerted.

II

It was not full five days after this occurrence that Gempaku got a copy of a Dutch treatise on anatomy.

Gempaku's original aim was information about Dutch medical science. He wished to learn Dutch so that he might thereby be able to understand Dutch medical books. This desire never left him, so when one of the interpreters showed him a copy of the "Tabulae Anatomicae" (Kulm's, 1731), hardly could he suppress an expression of joyful surprise. "Here is the whole secret of the human body," said he to himself when he looked at the minute illustrations of the internal organs in deep red and green. All through the pictures there were innumerable foreign terms. He could not read one of them, but he was burning with curiosity. From the very depth of his heart he felt a consuming thirst for this knowledge. He could not have it for less than three dollars, a sum that made a heavy demand on his poor purse. Without forethought he placed a small silver coin in the hand of the interpreter to close the bargain and left hurriedly for the mansion of his lord master to raise the balance of the fund. He submitted the case to his chief retainer, Oka, who was usually friendly to him, and always turned a friendly ear to his propositions. "If it is a really useful book, our lord will surely help you get it," remarked Oka, on hearing the urgent request of Gempaku.

Gempaku was moved. "I can say nothing very definite now, but you can be sure that I will do what I can to make it useful." He could not help promising this much.

There happened to be a samurai by the name of Ogura Saemon there, who helped the matter along by saying:

"Mr. Oka, pray help him. Dr. Gempaku is not the sort of man who will let your kindness go unappreciated."

III

It was on the third day of March. Gempaku proceeded to the Nagasakiya inn, where the Dutch captain and party were staying. Their interview with the Shogun was over. There was nothing to trouble their minds. They were lounging in idle, comfortable repose. Conversation flowed easily. The captain treated them to a very good wine called "Chinda."

There was quite a number of physicians there, but not Ryotaku. Their conversation was growing enthusiastic. Secretary Babble was a highly trained surgeon. Visitors, seated in a semicircle facing him, assailed him with all sorts of inquiries.

It was getting dark, and the Dutch people left for dinner. The visitors were fatigued and rose to leave. As they were rising, a message on red paper was handed to one of them. It was from the house of Dr. Jun-an, who happened to be one of the visitors.

The red paper was the sign of urgency. As he read it, the gloom

on his face faded and instead there reigned an expression of delight.

"Gentlemen! Rejoice! Our long-cherished desire is now going to be attained. The dissection of a corpse is to take place tomorrow at Kozukappara [Execution ground]."

He showed the note to all. It was an announcement signed by the chief judge from the city court.

"Dissection! Dissection!" everybody shouted. To most of them, the inspection of a dissected body was one of their long-cherished ambitions. This day, this moment, their desire flamed up, fanned by the information about it from Babble, the surgeon. Especially was this the case with Gempaku, whose anticipation was uncontrollable. He had been waiting for this occasion with that impatience which extends from "one day into one thousand revolving years" ever since he secured his "Tabulae Anatomicae" by the help of his clan lord. He noticed all the differences there were between the illustrations in his Tabulae Anatomicae and the traditional theories of the old classic Chinese doctors. Now he could have an object-lesson and compare the truth of the respective statements with the real object.

All faces glowed with joy.

"Let's go home now. We shall get up early to-morrow morning and meet at the rendezvous at Sanya-cho street." So spoke Jun-an to his party, and everybody nodded and agreed. At this moment, there flashed across Gempaku's mind the vision of Ryotaku's face. He knew well enough that Ryotaku was just as desirous to see the post-mortem dissection as everybody else. But the vague antipathy he felt toward him checked his impulse to speak. If Ryotaku were prevented from enjoying this rare opportunity, he said to himself, it would be no more than just retribution for his unfriendly attitude. Neither did he think it his obligation to remind others of Ryotaku when nobody else heeded him. When all rose to leave, he felt his conscience pressing him closer and closer. He was remorseful, for he could not help feeling the baseness of his intention. At last, however, his conscience got the upper hand of his vindictiveness. "We have been forgetting our friend Ryotaku," he said. "Let us take steps to let him know about this." Gempaku felt an immense burden removed from his heart.

"Sure enough, we have entirely left him out," echoed Junteki. "It would not do to ignore him." But there was no very enthusiastic support from the rest.

"It is already past 8 o'clock. It is a long distance to his residence from here. We can not help leaving him out. He may have another chance," said Jun-an, as if excusing himself.

Gempaku thought he might now very well observe silence. He had shown himself dutiful enough to his friend. He felt he was

under no strict obligation or responsibility to help Ryotaku enjoy this chance. But because he was conscious that there was lurking within his heart something that made him glad that Ryotaku would miss this chance, he thought it was not manly to remain silent.

"No, it is not absolutely impossible to let him know it," he said. "At the corner of this street, there is a courier's shelter. Just get one of them to drop a note. We can then accomplish our end quite easily."

It was a splendid idea under the circumstances. Everybody approved. Genteki sat down and wrote the note. Notwithstanding the fact that he proposed the idea himself, Gempaku's mind was not absolutely free of regret for having done so. The anomaly of human psychology! But instantly there came another thought that superseded it. He recalled his recently acquired book, "Tabulae Anatomicae." Something tickled his vanity. What a splendid occasion to show it to Ryotaku and to crush his pride. "However, I have done it, after all," he said.

IV

On the following morning at about half past 4 o'clock, he started from home and came to the rendezvous in Sanya-cho street, just when the boom of the bell of the Sensoji temple was resounding under the purple sky, announcing the advent of the new dawn.

On going into the room of the house, he found Genteki and Ryotaku already there, warming themselves over the brazier. He could not suppress his astonishment at finding Ryotaku already there, for he lived in a place far more remote than his own.

Ryotaku behaved himself with singular courtesy that morning. "I am deeply indebted to you for the messenger sent me through your friendship," he said. "This rare privilege is solely due to your excellent kindness."

Before this outspoken confession of gratitude, Gempaku could not help feeling ashamed of the ideas he had been entertaining about Ryotaku. "Dr. Ryotaku tells me," Genteki interposed, "he could not sleep a single wink last night. Our messenger came to him at about midnight and he left his house about 2 o'clock in the morning. He says he felt his heart dance within him during the two hours in bed, and could by no means sleep."

This information was disheartening to Gempaku. He found Ryotaku even more enthusiastic than himself. He felt himself inferior to Ryotaku in every respect, and experienced a queer helplessness. But the thought of "Tabulae Anatomicae" instantly dissipated this gloom from his mind. "I am the only one who possesses this rare book," he thought, which was strong enough consolation.

Meantime, Jun-an turned up; half an hour later, Shuntai and Ryoen came in company. Six altogether, they started for Kozukappara.

It was very snappy with the fresh morning breeze of the early spring blowing in their faces. They went on talking gaily. They were all past middle age, but their hearts bounded with hope. Their paces quickened as they walked on. Jun-an, a man of very short stature, was in danger of being left behind. Gempaku thought of disclosing his hidden treasure of "Tabulae Anatomicae." He had already once missed the chance of disclosure at the rendezvous in Sanya-cho street. As they approached the laboratory of Kozukappara, they saw a recently severed head on the exposure stand, the head of an old woman. They immediately decided that it was the body of this head that was to be dissected on this occasion. It was gruesome.

The chief executioner guided the party to the guard room of the officials, which was located at the entrance of the execution place. They had to wait till the preparations were completed.

Gempaku was about to lay his hand on the "Tabulae Anatomicae" in his pocket, as he thought the right moment had come, but simultaneously Ryotaku commenced to undo a package which he had been carrying in his left hand. He did this as if its presence had suddenly flashed on his mind.

"Gentlemen! I have something to show you. I bought this book down in Nagasaki last year. I have been keeping this all to myself ever since. A book on Dutch anatomy, I am sure."

So saying, he took out a book and placed it before his comrades. Genteki took it up, his eyes kindling with curiosity. The attention of all was focused on it. Gempaku, the owner of the same book, could not help doubting his own eyes. It was a copy of the same edition which he had cherished.

He remained aghast for a while. The last chance, on which he had placed so much hope, of taking Ryotaku by surprise faded away instantly. None the less, it was not advisable for him to keep his book concealed any longer.

"Dr. Ryotaku, you have that copy? I bought a similar one quite recently."

He said this with apparent indifference, but felt none of the thrilling joy and cheerfulness that he had expected the day before. It was, in fact, a bitter disappointment.

Ryotaku took up the copy and appeared to be deeply moved. He looked at it from cover to cover, overcome with curiosity.

"Undoubtedly the selfsame book. Strange coincidence, indeed!" he said.

Ryotaku repeatedly clapped his hands. His attitude was as open and frank as the blue of the skies.

"This coincidence is very lucky for the future of Dutch medical science in this country, I should say." He burst into a guffaw. Then he called Gempaku's attention to one of the illustrations inserted in the book.

"Look here, this is the lung, here is the heart, there the stomach, there the spleen. Nothing could be more unlike the traditional teachings of the Chinese doctors. To-day we shall see from the actual body which teaching is correct."

Ryotaku's face beamed with hope, disclosing his deep interest in the search for truth. His noble enthusiasm extinguished the unworthy sentiment that was troubling Gempaku's mind.

V

The party adjourned to the laboratory.

In one corner there was a shaky shelter with straw mats on the walls. They found a physician waiting for them. There were three professional executioners and two policemen.

As they had thought, the body was that of the female head they saw exposed a while ago, an old woman called "Greentea Hag." She had murdered a number of foster-children. People talked much about her romance in youth, and now even some years over fifty, there were no wrinkles visible anywhere on her body.

The executioner, Toramatsu by name, nearly 70 years old, took up the knife. In spite of his old age he was of sturdy build with ruddy complexion. One received the impression that he got his red face from the countless number of criminals who fell under his sword. He told in a boastful way how he had been accustomed to dissection since his youth.

The corpse was sickening and repulsive, and enthusiastic as they were in the search for truth, they could not resist the temptation to turn their faces away from this headless trunk in front of them. They felt choked by the ugly feeling that entered their systems through their eyes and noses, but they stood it with desperate determination.

The sharp blade of the old executioner, who held it point downward, ripped the chest open. It reminded one of butchery. Hardly half an hour had elapsed since the head had been severed. Blood, still warm and half clotted, came out as the blade plied its way.

The chest was laid open first of all. With all-absorbing zeal, Ryotaku, Gempaku and others engaged in comparing the anatomical illustrations with the corpse, that was being opened, red and crimson, before their eyes.

What wonderful accuracy! Not a single bone, not one line of the weird looking whitish fibrous tissue which runs like a network between layers of flesh, not one lump of yellowish fat, swelling up soft and roundish, but was represented in the illustration. The lungs, the red peach-shaped heart looking up from under the left lung, each was just as it appeared in the picture of the corpse in the "Tabulae Anatomicae." Deep feeling formed a lump in every throat.

Then the abdomen was dissected. The position of the stomach, the bowels folded in an uncanny mysterious form, and then the other various intestines behind the stomach, all were exactly like the picture.

"Wonderful!" shouted Ryotaku, coming out of his trance, and those about him also voiced their astonishment.

On their way home from the execution ground, two fell behind. Ryotaku, Genteki, Jun-an and Gempaku were stirred by the excitement of the demonstration, overwhelmed by the wonderful medical science of Europe. For the first half hour they kept a deep silence, full of emotion. As they passed by the water field of the Asakusa district, Jun-an broke the silence.

"To-day's experiment goes beyond our expectation," said he. "What a shame to have remained ignorant of such facts! Are we not all men who take generous pensions from our lord for medical services? Is it not indeed unpardonable for us to have remained utterly in the dark about the system of human anatomy? However, it is not yet too late if we start now. Let us study every grain of truth about the human body, the foundation of everything else. This is a noble duty that should bind every one who chooses to follow the medical profession."

This did not fail to move everybody to unanimous agreement. Gempaku followed Jun-an's remark by saying:

"You are quite right, and this makes my interest in this book all the stronger. Would that I could translate it! A translation of this single volume will clear away every mystery about the human body, and so will be very useful from the therapeutical standpoint."

To this Ryotaku quite frankly replied: "Yes, indeed! You have my whole-hearted sympathy. I have been anxious to read Dutch books for years. Only I have had no friend to help me, no one to go to. So my days have passed in useless contemplation. Nothing can afford me greater pleasure than to have you for my companion. Fortunately, there remain in me some fragments of the Dutch language, which I started to study during my stay in Nagasaki last year. I will study further in order that we may learn what is in this sealed book. What do you say to starting right away?"

All expressed their approval, clapping their hands. They were all united by a single strong emotion.

"It's never too late to do good! Let us hurry. All of you come to my house from to-morrow on," said Ryotaku, his big round eyes beaming with hope.

VI

According to promise, from the next day on, the four met in Ryotaku's residence in Hirakawa-cho street five or six times a month. The three others could not distinctly make out even the Dutch alphabet. For some time Ryotaku gave them introductory lessons. His stay in Nagasaki had enabled him to read and to understand a little of Dutch grammar. This was, however, nothing very substantial. After a month he found his stock of knowledge exhausted.

Now the four faced the "Tabulae Anatomicae" for the first time. From the very first page they felt as though they were sailing a rudderless boat on the expanse of a broad ocean. They were at a loss as to where to commence.

Near the front of the book there was a picture of a human body lying on its back. They said it would be easier to take up the study of the outside surface of the body because they could compare the Dutch nomenclatures mentioned in the picture with what they actually knew about the human body. The internal organs had better be left for a while, for sheer impossibility of comparison.

This was a fine idea. They took to searching in the pages for the names of the organs illustrated in the picture, and in this way succeeded in learning the names corresponding to the mouth, the brow, the hip, the ear, the abdomen, the legs, the hands, the heel and so forth. But mere knowledge of the vocabulary could avail nought for understanding written sentences. Often they labored in vain over a single clause or phrase throughout a whole spring day. At one time, after two days' hard struggle, they succeeded in making out a sentence which purported to be, "The brow is the hair growing over the eyes." They would break into laughter over such hard-won trifles, but could scarcely suppress the tears of rejoicing.

From the brow downward, they stumbled upon a phrase which states that the nose is a thing that does "Fulhessend." There was no good dictionary available, except the little one which Ryotaku brought back from Nagasaki. "Fulhessend" was explained in it as a swell that will grow on the spot left by the branch sawed off, or a mound the dust makes when a garden is cleaned. This was hardly enough to enable the four to get the idea.

Murmuring the word in their mouths, they thought it out from 10 o'clock in the morning to 4 o'clock in the afternoon. The four looked blankly at each other without exchanging a single word. A little past 4 o'clock, Gempaku jumped up with an expression of joy on his face, slapping his knee with his hand.

"I have it. Just saw off a branch, and the stump will swell up as it heals. The garden rubbish will also form a swell, when you clean it, just as a nose makes a swell in the center of the face. 'Fulhessend' can't be anything else than a nose."

The four clapped their hands with glee. Gempaku's eyes shone with joyful tears. The delight of possessing a world-famed jewel could hardly have surpassed it. Thus it fared with easy simple words, but when it came to a word like "nerve," for instance, a month's time could not work out a solution.

They used to mark a crossed circle on an incomprehensible word and called it a "Gag-cross." Innumerable Gag-crosses were scattered all over the pages throughout the book for the first year. But what could not their intrepidity conquer? Their painstaking efforts were rewarded. Over a year passed, and there was a considerable increase of translated words and as considerable a decrease of "Gag-crossed" words.

The hardships which a pioneer experiences are sufficiently rewarded by the exultation that only a pioneer can appreciate. With the growing understanding of words and sentences, priceless knowledge of truths which were literally a sealed book to their fathers permeated them like the sweet of a cane stalk. The joy of stepping on the fertile land of science unexplored by their predecessors gave them dauntless courage. They used to toss about in bed waiting impatiently for the dawn on the day appointed for a meeting, just like children on the eve of a festival day.

VII

The slight antipathy which Gempaku used to feel against Ryotaku had now vanished without leaving even the shadow of a trace. He had come to hold a very high opinion of Ryotaku's personal character and of his deep interest in science.

As, however, their work progressed, Gempaku came to notice a gradual divergence growing between his ambitions and Ryotaku's. Gempaku aimed at the translation of the "Tabulae Anatomicae." He wished to publish the work at the earliest possible date so that it would advance therapeutics and furnish a stimulus to inventive genius. It must have taken several generations, nay, centuries, of untiring effort before the study of the Chinese classics attained the peak of its development. So must it have been with Dutch

learning. Rather would he concentrate his energy and efforts upon a concrete piece of useful work and complete it in his lifetime than embark on a scheme too stupendous for the lifetime of a single man. It was certainly pleasing to look at the mingling of varicolored threads, but practically it would be more useful to have one single definite color and discard all the rest. Thus he thought, and had nothing else in his mind but the translation of "Tabulae Anatomicae." The day's portion of his work he never neglected to put down in black and white when he arrived home.

The case was different with Ryotaku. His views and intentions were broad and far-reaching. He aimed at the consummation of the study of the Dutch language. To the solitary "Tabulae Anatomicae" he gave but little attention. The complete mastery of the Dutch language and the ability to read and understand Dutch works in general—this was the goal of his ambition.

For the first year or two there was no open conflict of views between Gempaku and Ryotaku. But as their study progressed they used to dispute once in a while.

"The meaning is clear enough here, let's go ahead." Thus would Gempaku always hurry.

"Don't hurry, take your time. The meaning is clear, but as long as we haven't the grammar, it is little better than mere guess work." Thus would Ryotaku answer quietly.

VIII

Four years passed. Gempaku rewrote the translation twelve different times. There still remained five points they could not make out and seventeen they were not very sure about. Gempaku urged speedy publication, but Ryotaku would not consent to it as long as there remained doubtful or unintelligible points.

They discussed this point several times without being able to reach an agreement; they naturally could not, because divergence came from the fundamental difference of their ideas about Dutch science.

Gempaku at last made up his mind to publish the work, but could not disregard Ryotaku, for it was mainly he who did the translation, though Gempaku took down notes on it. So he called on Ryotaku to write the preface, which the latter refused to do.

"Once, while on a tour in Kyushu, I visited the temple of Temmangu and made a sacred oath that I would study the Dutch language not for fame or profit, but for getting a right key to truth," said Ryotaku. "I prayed for God's protection in this sense and I do not think I should be abiding by it if I wrote a preface as you request. I beg to be excused."

Gempaku could not help feeling depressed, but he could not bring himself to give up his idea. He could understand Ryotaku's attitude, but nevertheless he carried out his determination.

In later years when Dutch learning in Japan had attained considerable headway he recorded his impressions of those earlier days as follows:

"My thoughts were rough and my learning was shallow. I had no ability to make a translation in very comprehensible Japanese, but I had to do it because no one else would undertake it. I had not tried to force the translation of sentences, when I was not quite sure about their meaning, even when I suspected a rather deep implication. I gathered only those portions that I could well understand. I did not take time to particularize fully, for I had to hurry. This was a pioneer attempt, and a pioneer attempt can never be undertaken if one is too nervous about his future reputation. The pith and gist, that was where I had put the greatest stress. Had it not been for Ryotaku, the road could never have been paved. But had it not been also for a man who could neglect minute details for the sake of rough and broad essentials, never could this undertaking have reached such a quick conclusion."

DISTRIBUTION OF STATURE IN THE UNITED STATES

By Dr. CLARK WISSLER

AMERICAN MUSEUM OF NATURAL HISTORY

THE stature of man has always been a matter of interest. Most people prefer to be tall, and everywhere the short have a feeling of inferiority. The small races look upon the tall with envy, and so one may have reason to expect that if the law of selection operates in such affairs, people should grow taller, or at least the tall should segregate from the short. So, in keeping with this popular interest in the subject, stature has received scientific as well as practical attention. Every one in our country is measured many times in his life: the tailor applies the tape to fit clothing; the doctor and the educator test for growth and development and even for mental age by the stature rod; and when one comes to be insured, enlisted or perchance arrested, his stature is again taken. There is thus on file in the many archives of this nation a mass of stature data. The countries of Europe, also, have amassed data of this kind, and, having universal military service, they have in one way and another recorded the statures of their populations by districts. It is plain, therefore, that geographical distributions of stature are available, especially in Italy, France, Germany and Scandinavia. In some cases special surveys of a nation's population have been taken, and several important facts have been revealed in this way. Thus, one finds not a uniform stature throughout a nation, but geographical segregations. Again, the average stature of a nation changes from decade to decade, seemingly increasing, suggesting that mankind as a whole is growing taller.

Somewhat in contrast to the military nations of Europe, the United States has little data of this kind in its national archives; but, on the other hand, there is an abundance of records on file in schools and insurance offices, though not readily accessible. However, the late war, with its universal draft, did give us for the first time a nationwide sample of stature, the data for which were recently published by the surgeon-general's office.[1] In compiling

[1] The Medical Department of the United States Army in the World War, Volume XV, Statistics, Part One, Army Anthropology, Based on Observations made on Draft Recruits, 1917–1918, and on Veterans at Demobilization, 1919. Prepared under the direction of M. W. Ireland by Charles B. Davenport and Albert G. Love.

these data, the several states in the Union were sectioned according to the constituency of population as recorded in the census of 1910, thus dividing the United States into territorial units, each approximately homogeneous in all its parts. Though such a sectioning of the country is somewhat arbitrary, it is, nevertheless, the most satisfactory way of districting for the study of stature, as by this method a district like Detroit is separated out as one unit, while the Ozark Mountain region of Missouri is another, etc. The number of such units in the surgeon-general's list is 156, and the publication referred to above presents the stature for each of these sections. Thus, there are available convenient data for an analytic study of geographical distribution, an aspect of racial anthropometry so far neglected; for, though thousands of measurements have been tabulated and published in technical form, no one has ventured to deal with the subject in a constructive way. Anthropologists, for instance, have shown little aptitude in the use of such data when interpreting population and racial phenomena and, strange to say, have rarely considered the geographical distributions for such well-known characters as stature and breadth of shoulders. So advantage should be taken of the data accumulated during the war to develop a new approach.

If, then, we take a map of the United States and check in the statures for these 156 sections, the geographical distribution for degrees of stature will be revealed. The range of average statures for these sections is from 66.4 to 68.7 inches. Rhode Island has the lowest average, while the highest is found in North Carolina. But, if we treat statures in the usual manner and divide the series of averages for the population sections into quartiles, and plot, we get an interesting result (see maps). The first striking point is that the populations of large cities (marked by circles) are mostly short and that of the sections with similar stature all save two are in northeastern United States. No city is tall and but two, Minneapolis and St. Paul, are above the national average. On the other hand, the tall populations prevail in the mountain districts of the south and in Arkansas, Kansas, Texas and Oklahoma. The other sections for tall stature are chiefly in the west and are sparsely populated. Turning now to the median grade of stature, those just above and below the mean (the shaded areas), we note first that those below the mean tend to cluster around the short in fringes, while those above gravitate toward the tall. The tendency is clearly toward a segregation of the short as opposed to the tall. If now we note the geographical relations only, it appears that in the main tall statures tend to the inland, whereas low statures cling to coastal and other margins of our country.

Of other measurements available we have plotted chest circumference and the index for build, so as to make them comparable to stature. First, as to chest circumference: The largest chests are clearly in the north and west, while the low values cluster on the opposite side of the country. If a line were drawn from Boston to Los Angeles, it would divide the country into two parts, the large chested on the north, the small chested on the south. The cities falling below the line are, with one exception, small chested; yet those above fail to reach the upper group. As in the case of stature, the cities fall in the lower parts of the series for the nation as a whole. There is also a tendency for the smallest chests to be inland with higher values on the margins.

The index of build used in the army tables is found by dividing the weight multiplied by 1000 by the square of the stature. Plotting the values so obtained, we get a striking result, in that the different grades of build are quite clearly segregated. The low values are in the south, the high on the north. The cities tend to be high, the reverse of their relation as determined by stature.

The three foregoing distributions deal with size characters in our population and show clearly that with respect to this character, our population is segregated geographically. The consistency with which all the size measurements for the army fall into this general scheme of geographical segregation indicates that the data are reliable and the nature of the distribution raises a number of important problems. For one, what are the causes that result in such geographical segregation as we have observed and are they peculiar to the United States?

But to deal effectively with our data the respective variabilities must be considered. What variability means as used here is this: If the difference between the tall and the short men for one section is small, we say the variability is low; if great, it is high. Or, when variability is low, every person will be nearer the average size than in a section where the variability is high. This range in size is usually expressed by the mean deviation of individuals from the group average.

Fortunately for us, these deviations have been calculated for the army data and as we are now concerned with geographical distributions only, we may plot these values as before (see maps).

The range of variability for stature, for example, shows a distribution the reverse of that for the average measurement, since the region for low stature is a region of high variability; the same region was, however, distinguished as one of maximum chest size and it is also the place of high variability in chest measurements. Eastern United States, especially the North Atlantic area, is then a region of great range in size. This may mean that among the popu-

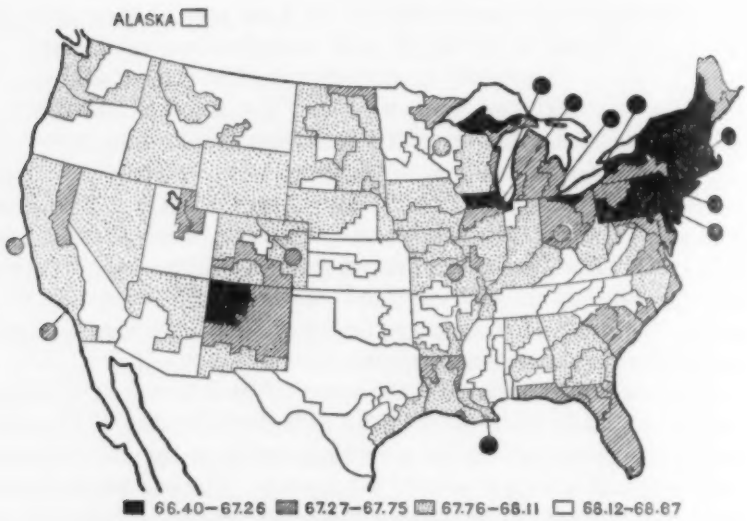

FIG. 1. STATURE

lation of this region will be found some of the tallest men in the whole country and also some of the shortest, but since the average is low, the latter will dominate.

Returning now to distribution, it appears that the phenomenon of variability follows the law of geographical segregation also, but is not directly correlated with size. Again, both averages and variabilities show a tendency to differentiate between inland and marginal distributions. Knowing the history of our population, the interpretation of this is obvious. It means that the older colonists were tall, whereas those arriving recently were short.

DENSITY OF POPULATION AND BODILY SIZE

The sections on our maps vary greatly in density of population, ranging from 0.5 to 16,667 persons per square mile. As every one knows, our cities are the centers of maximum density, but they are also the centers of low stature. To repeat, we found the cities of our country below the average in bodily size, and it is clear that in all cases the city differs from the surrounding districts. Hence, these relations can not be due to accident, for, if chance ruled, one should expect some cities to be populated by very tall people, others by short. Since we find it otherwise, some selective factor must be assumed.

It may be that the phenomenon is entirely a matter of density in population, or, what is more probable, that social conditions draw the short into the cities. The relations here can be made clearer if we consider the calculated variabilities. We note that thirteen cities

have high variabilities in chest circumference and while the case is not so striking for stature, yet no city falls in the class of low variabilities.

Further, if we turn to the actual army tables as published, we find that without exception the inland cities are surrounded by belts of lower variabilities than their own. Thus, the tendency of cities toward high variabilities is indicated. This is also characteristic of cities in Europe and may be taken as a universal law of populations, and, formulated broadly, may be expressed thus: The populations of cities will differ from the surrounding districts in both size and variability.

As confirmation of this we selected the thirteen sections in the United States, characterized as distinctively rural, and also fourteen large urban sections, with the following result:

	St.	Var.	Chest	Var.	Build
Rural Av.	67.87	2.59	34.0	1.95	30.90
Urban Av.	67.10	2.67	33.16	2.07	31.18

So taking the law of differentiation for cities as established, we turn to the question of density, for if this always accompanies these changes, whether conditions are rural or urban, then some causal connection exists. This, also, can be handled empirically.

SECTIONS DRAWN AT RANDOM FROM THOSE WHOSE DENSITY FALLS WITHIN THE LIMITS STATED AND GROUPED ACCORDING TO VARIATIONS FROM THE NATIONAL AVERAGE

	Stature		Var.		Chest Circum.		Var.	
	+	—	+	—	+	—	+	—
9 Sections, density less than 4 per square mile	9	0	1	8	9	0	2	7
9 Sections, from 60 to 80 per square mile	1	8	6	3	2	7	8	1
9 Sections, from 150 to 500 per square mile	0	9	2	7	3	6	8	1

If, for example, we take the density ratings for the sections and sample for high, low and medium densities, the result will be like that in the accompanying table. In this tabulation we have excluded the large cities. What we find is that size both in stature and in chest circumference decreases with density. Variability, on the other hand, tends to increase.

The significance of this is far from obvious, because the districts of median density are not predominantly urban. Still it may, for all that, be a characteristic of the town, or that as the economic and social status approximates that of the city, the population will be affected as stated. As a check upon this we can turn to corresponding data for Sweden and Italy. Thus, the stature for Sweden as a whole is 170.8, and while Stockholm is credited with a stature

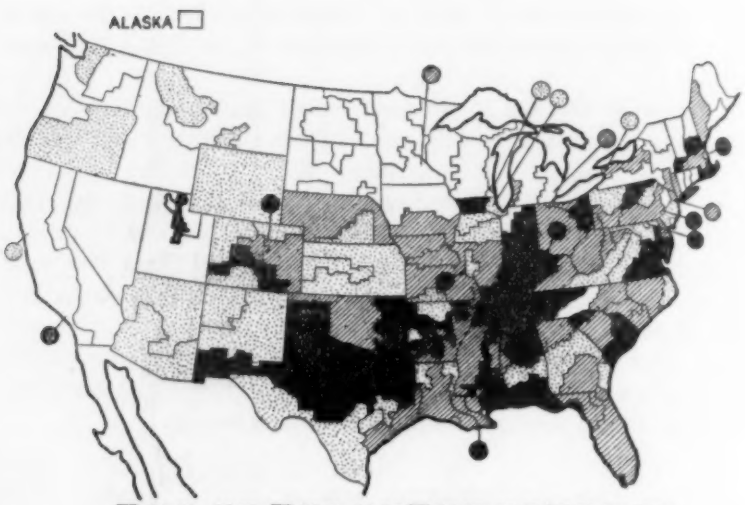

FIG. 2. CHEST CIRCUMFERENCE

of 171.3, the maximum stature for the provinces is 172.9. Yet if we take the provinces with large cities—as Bohuslän, 172.1; Skäne, 170.2; Halland, 170.1; Smäland, 170.5; Ostergotland, 170.4; Uppland, 170.7; Vastermanland, 170.5—it appears that all but one are below the national average.

Turning now to Italy, we find the national stature to be about 164.5, ranging from 161.5 to 167.5. The three large cities are: Milan, 165.7; Naples, 164.2; Rome, 164.2.

Ten other cities above 50,000 in population range from 162.5 to 166.3, and but three are below the average stature. In Italy, then, it is by no means clear that the short congregate in cities, but rather the reverse.

What we observe, then, is that in Sweden the tendency is for stature to fall in the densely populated provinces, but in Italy to rise. This is not so contradictory as it seems, for if we accept the statement that all cities draw foreign stock, it would follow that since the Italians are shorter than most European peoples, the alien elements in their cities would be taller or above the Italian average. On the other hand, the Swedes being a tall people, the tendency of the alien would be to lower the stature. To generalize, then, the cultural conditions in Europe and America are such as to draw into the centers of dense population immigrants from all countries. If the native population of a city is tall, such immigration will lower the average stature; if short, the reverse will follow.

It is, therefore, quite improbable that either city life or mere density of population has any effect upon size, the phenomenon we have noted being entirely a matter of migration.

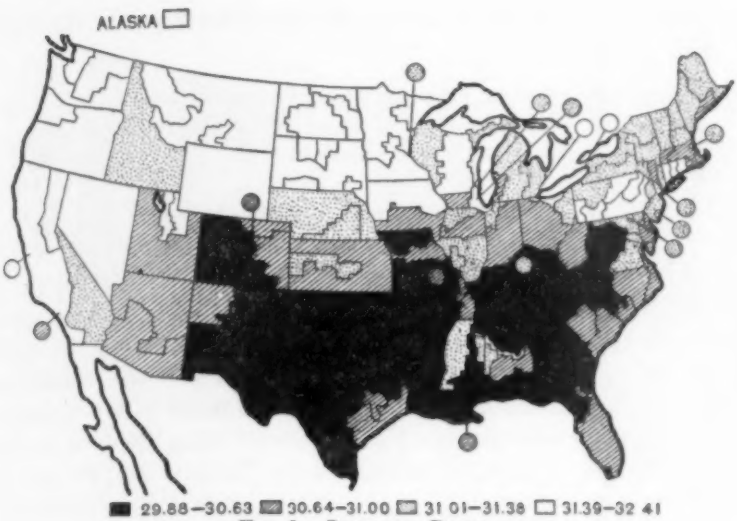

FIG. 3. INDEX OF BUILD

THE RACE FACTOR

While we are now confident that the primary cause for the differences we have observed is racial, we do not know how any given race affects the average national stature. We can, however, approach this problem in our own population by well-known statistical methods. As previously stated, the racial antecedents of the population sections for the United States used in this study are known, so it is possible to single out a given racial strain and determine its correlations. One can, for example, trace the Italians through all the sections and note how their presence correlates with stature. As we know them to be a short people it follows that an increase in their numbers would lower the average stature. Turning to the army tables, we see that 66 sections show an appreciable proportion of Italians, ranging up to 10 per cent. So, by the method of correlation, one can calculate the relation between average statures and the percentage of Italians. The technique of this need not be stated here, for all one needs to know is that if the presence of Italians increases stature, the coefficient of correlation will be +, but if they decrease it, —. What we find when we correlate the percentage of Italians with average stature is a correlation coefficient of — 0.72, which would imply that the presence of Italians is the chief cause of low statures in the United States.

In the accompanying table will be found a number of similar calculations. Degrees of correlation range from 0 to unity and when the number of cases rises to a few thousand, can be expressed accurately to the second decimal; but with so small a series as we

have here, one must allow for considerable inaccuracy in the first decimal.

APPROXIMATE CORRELATIONS BETWEEN THE PERCENTAGES OF FOREIGN STOCK AND BODY MEASUREMENTS

	Stature	Chest
Italians	−0.72	−0.47
Scandinavians	+0.46	+0.31
Negroes	−0.05	+0.06
Foreign born	−0.42	+0.32
Native white	+0.85	−0.23

Yet in spite of the great probable error in these calculations, we have a consistent result; as when the stature increases rapidly with the number of native born whites and declines with the increasing number of foreign born. The latter includes many of the Italians, but not all, those of immediate Italian descent being included in our first correlation. Again, in contrast to the Italians, the presence of Scandinavians increases stature; being a tall race, this is consistent.

When we consider chest dimensions the Italians are again responsible for reduced size, but so are the native whites. The Scandinavians and the foreign born increase chest size. This is again consistent, for the data on chest measurements show high values for the Scandinavians, Germans and Poles, while the native whites, especially the southern mountaineers, are conspicuous for their slim chest.

Turning now to negroes, we find them in the main neutral, since their coefficients are too small to be significant of more than an accidental relation. In other words the negro, who usually lives with native whites, is too near the latter in stature and build to affect the average.

In general, then, by the method of correlation we can analyze a composite population and estimate the influence of different strains upon average size. This method is a promising one, and, if systematically followed, should reveal the part each racial strain now plays in the formation of our population.

THE SIGNIFICANCE OF VARIABILITY

One of the accepted principles of biometrics is that purity of strain determines the degree of variability. Studies of stature, for instance, indicate that the variability from the average will be low when the population is of a single race, but high when a number of races are thrown together. This is obvious, for if Italians and Englishmen are grouped in the same regiment, the range of statures will be greater than for a regiment of Italians only, or again exclusively of English, the reason being that the average stature for Italians is much lower than that for Englishmen. So, in dealing

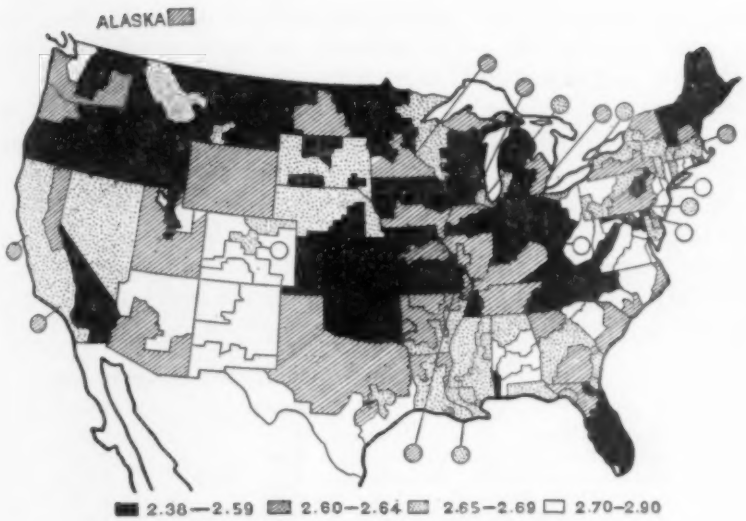

FIG. 4. VARIABILITY IN STATURE

with United States Army data, when we note that the draft quota from a city shows a high variability, we are justified in concluding that several races are represented in its population. Of course, in many instances we can arrive at the same conclusion without measurements, but it is important to once establish the law, since then it can be used to interpret populations for which we have no other data.

However, we have not considered all the possibilities in the case, because geneticists tell us that race-crossing will also increase variability. It is easy to see how such an increase would follow in the early generations, if all characters conform to the Mendelian law, because then both parental types would be represented in the population. If, for example, we assume that tall and short statures, respectively, are unit characters, then the crossing of Italians and English would result in a number of short individuals as well as tall, from which we may infer that the variability for the mixed group will be greater than for the short alone. So on theoretical grounds, at least, the result for cross-breeding need not be very different from mere mechanical mixture, since both give higher variabilities. We see then that while mere measurement will reveal the presence of different racial strains it will not tell us whether the mixture in the population is mechanical or by blood, at least, not until we determine the relation of each to degrees of variability, for no one is prepared to say now if one kind of mixture necessarily gives a greater variability than the other.

Let us, therefore, turn to the first principle formulated above,

viz., that relatively high variabilities indicate the presence of two or more racial stocks. For instance, we have noted that cities seemed to exercise some kind of influence on stature, but found a satisfactory explanation of this in the tendency of different racial stocks to congregate in such cities. Further, it is not quite clear that this will account for all the observed segregation, but certainly for the major portion. As a test, we may check out a few of the largest cities and in contrast a few of the sections rated as highly homogeneous. Reference to the table will show that the latter are by no means alike in their respective racial compositions, but this will make our test all the more satisfactory.

VARIABILITIES FOR SECTIONS KNOWN TO BE HIGHLY HOMOGENEOUS

	Stature	Chest
Negro, Illinois	2.38	1.95
Indian, South Dakota	2.41	1.74
Scandinavian, North Dakota	2.48	1.88
Ozark White, Missouri	2.48	1.76
Mormon White, Utah	2.56	1.88
Russian, Kansas	2.57	1.98
Finnish, Michigan	2.61	1.96
For Large Cities		
Baltimore	2.69	2.08
Boston	2.64	2.14
Cincinnati	2.90	2.09
Chicago	2.67	2.12
New York	2.77	2.15
Philadelphia	2.65	2.02
Seattle	2.70	1.96
St. Louis	2.63	2.07

What the table shows is that the variabilities for the homogeneous sections are uniformly low. In fact, it is here that we find the lowest variabilities recorded for the nation as a whole, the lowest case being that for a section in Illinois populated by negroes. The next lowest is the Indian section for South Dakota, and next in order are the native whites of the Ozarks and the Scandinavian district in North Dakota. It is interesting to note, further, that in Utah, including Salt Lake City, we have a population of low variability, native white and North European descent, but possibly plural marriages have contributed to the result. Turning from stature to chest measurements, we note that the variabilities for chest girth are comparable to those for stature, all the ratings for these sections being near or below the average and so tending to be low. The cities, on the other hand, show high variabilities, as previously noted, and since we know that our large cities contain many racial strains, our test indicates that the law of low variability and racial homogeneity holds. It would follow then that all the black areas on our distribution map for variability of stature are the most homogeneous in population. But this does not mean that all these sec-

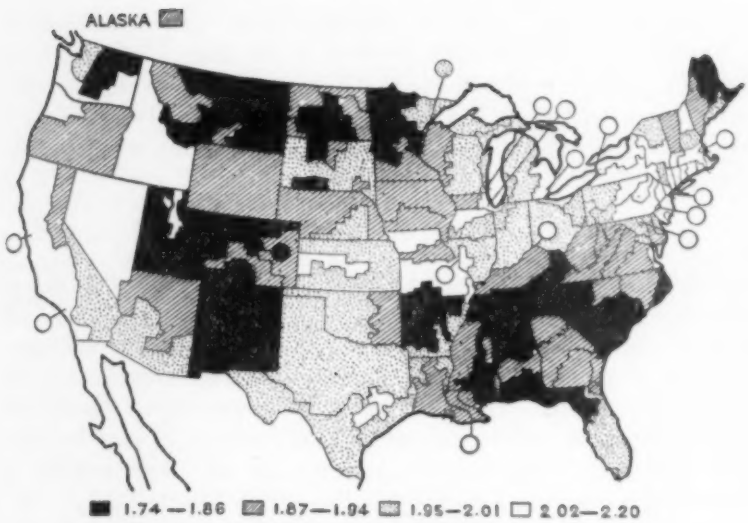

FIG. 5. VARIABILITY IN CHEST CIRCUMFERENCE

tions are of the same stock, for some are Indians, some Scandinavians, etc.

There is, however, still another test we may apply to the case; we can correlate the degrees of variability with racial composition as we did for size. The result is given in the table. From this it appears that the presence of foreign-born and of negroes tends to increase variability in stature, while the presence of native white and of Scandinavians reduces it. Since the native white are North Europeans, as are the Scandinavians, it follows that the increase in Nordics reduces variation in stature, whereas the increase of South Europeans augment it. Chest measurements are in the main consistent with this result:

APPROXIMATE CORRELATIONS BETWEEN THE PERCENTAGE OF FOREIGN STOCK AND VARIABILITY IN BODY MEASUREMENTS

	Var. in Stature	Var. in Chest Circumference
Italians	+ 0.49	+ 0.55
Scandinavians	— 0.64	— 0.83
Negroes	+ 0.14	— 0.23
Foreign born	+ 0.04	+ 0.52
Native white	— 0.30	— 0.45

In a preceding paragraph we noted a progressive change in size and variability with density of population. The sparsely settled districts, for example, tend to low variabilities, except where Indian populations interfere, while the rural districts are intermediate and the cities high. When exceptions are made for the sections of unusual mixtures, this relation holds throughout.

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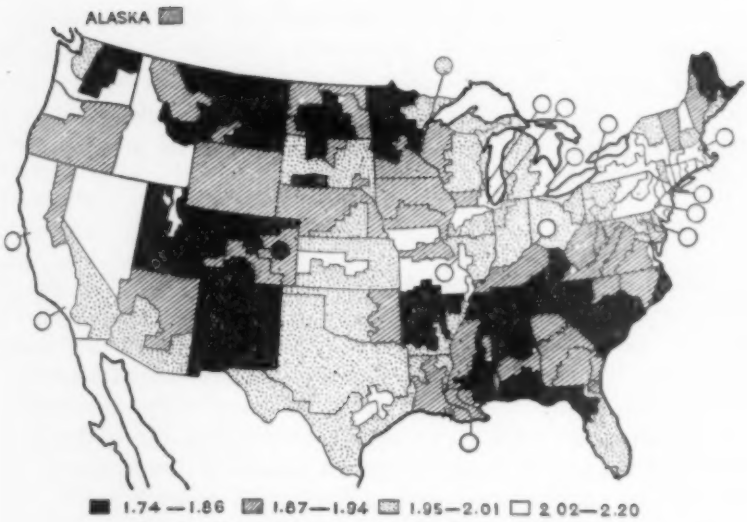

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In general, then, we have reasonable proof that the differences in variability for population districts in the United States are for the most part due to multi-racial elements. Cities, in which gather many races, will show the highest variabilities, while districts in which the population tends to be of a single strain will show the lowest variabilities.

Racial Strains and Variability

In the preceding sections we have shown the validity of the assumption that relatively high variability means the presence of two or more racial elements in a population. What we do not know, however, is the degree to which any one race increases the variability for the whole. Thus, in our correlation tables the Italians greatly influence variability, whereas the presence of negroes makes little difference in the measurements considered. Doubtless the answer to this question hinges upon the native variabilities for each racial strain. And most certainly must we turn to this problem when the effects of race-crossing are to be considered. If, then, it is true that the crossing of races increases variability, it should follow that by their respective variabilities the purity of populations can be rated. Such a law is generally accepted in genetics and not infrequently applied to human data. Yet data for a rigid test of the law are not available. All we have are a few trials at Indian crosses, but so far as these go they sustain the assumption. However, the United States army data lend themselves to a comparative treatment of racial variabilities and it is to these that we will turn.

A large number of soldiers were segregated according to racial descent and their variabilities calculated. So from the published reports we have compiled the accompanying table. We note, first, for stature, that the lowest variability is shown by the Italians and the highest by the negro; next to the Italians are the Irish, Hebrews, Poles, all with low variabilities, whereas the English and Germans are rated high. When we turn to weight, the positions of the racial groups remain about the same, the maximum shift being that for the Scotch. This is consistent, since stature and weight are correlated to a high degree and suggest that one must allow for a shift of two to three ranks in our table as accidental variation. Yet the question as to how much allowance we should make for mere accident can be answered by mathematics. Calculating according to the formula for deviations of the variability values in our table, we find that for stature differences of 0.20 and over have great certainty; for weight, differences of 1.50. It would follow, then, that the differences between the Italians, Poles and Hebrews, on the one hand, and the Negroes, English and Germans, on the other, are real differences.

Now, at the outset, we assumed that the less variable the character, the purer the race. If this principle holds, then the Italians and Poles can make the best claim to such distinction. But, if we turn to the column for chest circumference we meet with quite a different line-up, the negroes have shifted from the highest to the lowest rating; the other large shifts are the English, Irish and Hebrews. These shifts are rather surprising, for, interpreted according to the accepted principle, it would follow that as respects chest circumference negroes are the purest race, but in stature the most mixed. In much the same way one could say that the English

Stature

	Aver.	σ
1. Negro	67.70	2.72
2. English	67.75	2.61
3. German	67.73	2.60
4. French	66.37	2.56
5. Scotch	67.93	2.52
6. Irish	67.46	2.48
7. Hebrew	65.71	2.44
8. Polish	66.73	2.41
9. Italian	65.03	2.39

Weight

	Aver.	σ
1. Negro	149.5	17.53
2. Scotch	144.9	17.41
3. English	144.9	17.35
4. Irish	142.9	17.08
5. German	148.2	17.02
6. French	142.1	16.03
7. Hebrew	137.8	16.03
8. Italian	137.9	15.49
9. Polish	145.6	15.29

Chest Circumference

	Aver.	σ
1. Irish	88.67	5.31
2. Scotch	88.57	5.25
3. Hebrew	87.53	5.19
4. German	89.52	5.17
5. Polish	90.42	5.11
6. French	88.49	5.08
7. English	88.18	5.00
8. Italian	88.87	4.94
9. Negro	87.99	4.76

are highly mixed with respect to stature, but pure in chest dimensions. One accustomed to think of race purity as applying to every part of the body equally would at once dismiss this as absurd and reject the whole principle of variability as an index of purity. But the contradiction may not be so absurd as it seems, if one but recall the fundamentals in current views of heredity. What is suggested is that in data of this kind we have an approach to the study of human inheritance, but this is a problem to be discussed later. For the present, then, we shall confine our attention to stature, respecting which the evidence for the validity of the law of variability and race purity promises to be satisfactory.

So, accepting the tentative conclusion that the variability in this character is a true index of racial purity, we may consider the implication of our table with respect to Italian immigrants. Thus, have we reason to believe that the Italians coming here are more homogeneous than the English? But, before going farther, it is well to be reminded that any kind of selection, directly or indirectly correlated with stature, will leave its mark on the variability. We note, for example, that when we segregated soldiers according to race, the variabilities for stature were reduced. Again, we found that population sections composed largely of pioneers presented lower variabilities. So, since we are now dealing with the representatives of each race as selected by immigration, it will not be sufficient to compare national averages.

In case of Italians we know that the greater part have come from southern Italy. From Livi's tables it appears that all southern Italy is characterized by low variabilities in stature, the different provinces ranging approximately from 1.68 to 1.95 inches. So we have:

Italians in U. S. Army	65.03 ± 2.39	inches
Italians for all Italy	64.76 ± 2.06	"
Italians for Southern Italy	64.37 ± 1.95	"

Thus, the Italians in America are clearly more variable than Italians at home. This is an interesting point, which we can not discuss now; but the above shows that the difference between Italians and Englishmen can not be explained away as due to the selection of immigrants according to stature. For, notwithstanding that most of the Italians in the United States come from southern Italy, where the stature is low, the average for the United States Army is still above that for Italy as a whole. Of course, some allowance must be made for military standards, by which a large number of Italians would be excluded. However, this should reduce the variability, and there can be no doubt but that the United States Army variability is too low for Italians in America. The question is, then, can military selection alone account for the position of the Italians in our table? Properly to deal with this problem will require new investigations, but a try-out of the data at hand indicates that it will not, and that in so far as stature is concerned, we must assume positive national differences in variability. The probabilities, therefore, favor the validity of the law for variability as an index of purity, but this discussion shows clearly that it can not be grossly applied and that new researches along this line are highly desirable, for, as a method of studying race-crossing and comparing populations, it is promising.

Conclusion

The foregoing discussion but skims the surface, yet should make clear the richness of the available data as well as the need of ana-

lytic studies on our national population. The results of anthropometric research to date, if properly formulated, will reveal new leads in population problems. In our case we know the history of immigration to our shores, but there are populations in the world concerning which we have little save that derived from measurements. It is, therefore, quite worth while to experiment with these new techniques in the study of our people, where we can check the results. Once having established these methods empirically, one could proceed with non-historical population complexes, like the Polynesians, Indians, Mongols, etc. For example, by a very conservative application of the principles of variability as just outlined, one could sketch out accurately the history of immigration to the United States. With no more before him than adequate measurements of our population, county by county, one would automatically formulate the following:

(1) The greatest amount of racial diversity is in the cities.

(2) The purest communities are in rural districts.

(3) The southern states as a whole have a moderately mixed population.

(4) The regions of least mixture are: *a*, the Canadian border from Maine to the Pacific; *b*, a broad belt running from Ohio and Tennessee to the eastern border of Colorado and New Mexico, and *c*, a belt through the southern states to Texas.

(5) The fact that tall statures are found in the interior of the nation, while the shorter mass on the coasts and the inland borders suggests that the first arrivals were tall, but that these were followed later by a shorter people, and since these mass on the northeast coast, that there was the door through which they came.

Thus it is that anthropometry, when carried out on a large scale, is a most promising method for analyzing populations, even though our observations are limited to stature. Broadly considered, stature is an index of size and a knowledge of variations in size within our population is of both theoretical and practical importance. Clothing manufacturers especially have need of such knowledge in apportioning the sizes of clothing, for the regional variations we have revealed, large peoples in one part of the country, small in others, and the evident drift toward large size among all classes, present them with a perplexing problem. For the sake of this industry alone, a periodical survey of the nation's bodily dimensions is justifiable. But there are other reasons why such a survey should be made at regular intervals. The many and diverse racial elements now in our midst are certain to mix, and the effect of this upon size would soon be revealed by a regional sampling of the population. Such data would be the best approach to the deeper biological questions involved, particularly the specific problem of race mixture.

HALF-BREED

By Dr. ELSIE CLEWS PARSONS
NEW YORK

I

WE are sitting in the Chief's small frame house in a half-breed Micmac[1] settlement in Western Nova Scotia. The Chief is an old man, going blind and suffering, too, from erysipelas. This morning he was out when I arrived, but his son and daughter-in-law are there, and presently she has a story to tell me about the girl who married a horned snake. Sahkis, long ago, in a big encampment lived a girl. She was a very proud girl, unwilling to sit where others sat and rejecting all her suitors. An old man told her father that unless he made her marry the youth next to court her misfortune would befall. After that, one day, the girl went to the spring with her birch-bark bucket. She dipped, and as she looked into the water she saw sitting there, cross-legged with folded arms, a beautiful young man. He smiled at her, he stepped out of the water, he carried home for her the bucket of water. "My son-in-law!" said the girl's mother in greeting as he came into the wigwam. In those days that meant marriage. So they married and had a son. "Let us go to my home," he said to his wife, "my parents would like to see my child." Then with child and maternal grandparents they went to the lake into which the spring flowed. At the edge of the lake he said to the old people, "Don't look for us again," and then they saw two large horned snakes and a little snake going into the water.

This widespread Indian tale (I have heard it across the conti-

[1] The Micmacs are an Algonquin tribe of Nova Scotia, Cape Breton and Prince Edward Islands, New Brunswick and Newfoundland. They were among the first Indians of the northeast coast encountered by Europeans; the three Indians taken to England by Sebastian Cabot were probably Micmacs. The tribe became friendly to the French and even after Acadie was ceded to the English in 1713 the Indians remained hostile, until the latter part of the century. They were estimated then and since as between three and four thousand. (Handbook of American Indians, Bureau of American Ethnology.)

To-day the scattered Micmac settlements consist of frame houses in place of the log cabins of half a century ago and of birch covered wigwams. On the annual tribal pilgrimage to Chapel Island wigwams are set up and old ways of life revived. In certain folk-tales and in religion the French influence is still conspicuous although Scotch Catholics say mass and the folk-tales can be told in English. With French and Scotch and English there has been much intermarriage.

nent) was told Mary by her father in Cape Breton. Her father's name was Piel (Pierre) Paul, but he was also known as Moose, because his great-grandfather killed moose easily, with a little knife, which means that he was a shaman with hunting magic.

Mary's story of lure unresisted prompts a story of resistance to lure from Jim, who is splitting maple for baskets, Mary's work, but Mary's hands are stiff from rheumatism and Jim is learning how to make her baskets. Jim's story is a personal experience, with one of the *migumwésu*. "Thirty years ago," he says, "I was eighteen. One day in the woods I saw the shadow of a woman, awful pretty woman. She couldn't speak to me. I couldn't speak to her. After that for two or three years whatever I worked for I got, very easily. If I was fishing, I got lots of fish, plenty animals in my traps. Then I saw her again, in the woods, beckoning to me. If I follow her then, I be following her still. I went to the priest, to cut myself off, not to see her. . . . How's that, Mali?" He is pointing to the pile of maple splints at his feet. "All right, Jim."

In comes the old chief, holding out for us to admire the bunch of fine-toothed leaves and long yellow roots he has succeeded, in spite of his poor eyes, in finding. "That's good for sore eyes," explains Mary. "And it's the best thing, too, for his erysipelas. Since he's given up the doctor's medicine and used that, his leg is a great deal better."—"Golden Thread" in lieu of doctor's medicine, but priestly exorcism and convent-bred Mary and her work in lieu of Migumwésu and the charm that makes work proper to a man so very easy—a medley, indeed, the Half-Breed!

II

As we come down the green trail from Sarusalém into the encampment the people are standing outside their wigwams or are crowding on to the small dock, from which the schooner, which is the lakeway link between Chapel Island and the town of St. Peter's, is about to cast off. All eyes are bent on the boat, and, as we see, when somebody points him out, on a man sitting amidship and with his hands manacled. An unparalleled thing has happened this morning in the Mission camp—a man has tried to kill his wife. First he asked her to go out with him in his row boat to spear eels. She saw his crooked knife at his belt, and she was afraid. When she refused she was bending over their wigwam fire. He kicked her in the face. In the wigwam was one other person, old Stephen Sylliboy, uncle of the Grand Chief. Old man Sylliboy got out as quickly as he could and over to the chapel where most of the people, including the policemen, were holding their morning service. The policemen found the woman on the ground, her face streaming blood. When they handcuffed the man he said he would kill her yet, when he got out.

They had been quarreling for over a year, the story went, "jealousing each other," by which was meant that she was jealous of him, and kept nagging. This from a woman who adds, "But wasn't it good, Mistress, that he had on rubber shoes?" A man who tells me he is the woman's cousin is feeling highly outraged. "That woman, nice woman. Anyhow, man don't need to kick her in the face." "Better keep him in prison for some time," says his own stepfather. "He's all right, except when he drinks. But he wasn't drunk this morning. No whiskey on the Island."

Perhaps he was not drunk, only seeing red, for reasons that were probably not to be referred to in court, and perhaps there was no whiskey on the Island. But the night before, after the Sunday excursionists from Sydney had gone, had I not been offered by my ever hospitable hostess something which tasted more than I supposed possible like the traditional fire-water? "That Mr. McPherson, awful good man, Mr. McPherson, brings us one bottle, every year."

III

My hostess complains a good deal about camping. After her frame house and kitchen range, the wigwam and open fire seem uncomfortable. Next year they will have a canvas tent, she says, and a stove. And there is no water on the Island, the well was destroyed in the French and English War, we have to pay ten cents for a bucket of drinking water. Nor is there any birch-bark on the Island, people have brought bark rolls with them to cover their wigwam poles or, as we did, used tar paper. Hemlock and spruce there are, but Mr. Ahearn, as his wife always calls him, both in reference and address, does not like boughs to sleep on, so we have hay. Mrs. Ahearn is surprised that in my sleeping bag I do not want the cotton sheets she has packed in her trunk.

The trunk has the place of honor in the wigwam, opposite the door, so that when we have visitors of distinction, like the chief from Prince Edward Island or the Grand Chief, blanket and box seat have to be placed for them a little to one side. Otherwise, wigwam etiquette, which is very strict, is well observed. Mrs. Ahearn sits at the right of the entrance, the kitchen, next her, Mr. Ahearn, above her, never below. Between their guest and the fire none of the five children will ever step. Very mannerly, helpful and happy little children, as are Indian children. Only once have I heard any one cry; Eddie did not want to go to school, in the chapel gallery where every morning prayers are taught.

That afternoon Eddie was again saying prayers, as he went on his knees with all the others, perhaps one hundred and fifty, "to see

St. Ann." Men and boys first, after them women and girls, "crawling" inch by inch between Ave Marias, from the ground outside, up the steps, and along the center aisle to where the saintly image rested below the altar, there, still on knees, to kiss the saint's foot and "throw charity" to her, with the right hand; if coins are laid down with the left hand they are "lost to God." This is the time, says Mrs. Ahearn, if anything is the matter with you, and "your heart strong," you are cured, "*sure cured.*" As those devout kneelers moved slowly on, one staid behind, on the porch, a boy of about fourteen. His hands were horribly distorted, and on his neck were sores that sickened. "Rotten since born," says Mrs. Ahearn, "the king's evil, what's that, Mistress?"

Thursday, at latest, I have to leave the Island, a day behind schedule because I want to see what I can of the men's dinner and meeting on Wednesday, and afterwards perhaps, the old-time dance. As yet only "sets" have been danced, to a fiddle, in a packed room in Glebe House, each youth contributing ten cents a set. The Grand Chief has heard indirectly of my intention and wish. He comes in to see us. "What will you throw if I advise my people to dance Indian dance on Wednesday?" he asks, in course of time. "If you leave Thursday and we don't dance Wednesday, perhaps you never see that dance." "Yes, and I would be very sorry for that," say I, "I will throw five dollars." I ask if I may come in to the meeting. I may not, no women are allowed, it would spoil the men. Once a chief's wife went in, and the people did not like it at all. "But I will show you my crown," says the Grand Chief, and he holds out the large gold medal which hangs to the chain around his neck. "That, nice man, Grand Chief, show you his crown," comments Mrs. Ahearn, after he has left. "And ain't you lucky, Mistress, to see Indian dance? Money breaks through everything." "Now, Ina Claire, my dear, you know the Grand Chief was going to have the Indian dance Wednesday anyhow; he told me so himself when I first came. But I'm glad to give the $5.00, anyhow." "Yes, we all feel that way here," rejoins that very resourceful woman. "We throw *everything.* Go 'way, nothing left. Money gone, grub gone, clothes spoiled. . . . We come again, next year, though. . . ."

The men's dinner is eaten at about four o'clock, by the chiefs and captains in the grand wigwam, and, outside, by all the other males, including the little boys. The women have put on their best clothes and sit or stand in front of their wigwams, forming a kind of ladies' gallery. We can hear speeches inside the grand wigwam, and then one by one the captains and the chief from Prince Edward Island come out to be acclaimed by the ring of men seated cross-legged on the ground.

Kwanodek! Kwanodek! sings each as he comes out, a word of forgotten meaning, to a dance step that makes the ladies giggle, except when it is done by the Prince Edward Islander, who stamps with a style we all admire; it is the shame-faced shuffle of our own familiar captains that seems comical. Dance steps alternate with shouts from the sitting men, each of whom is shaken by the hand, "saying bonjours," then, with a final wave of the hat, "wishing good luck to all," captain or chief withdraws into the wigwam. More speeches from within, the chapel bell tolls "the angels," and all go in to the chapel service, this evening to make the stations of the cross, the groups moving in circuit from picture to picture.

Now one more circuit to conclude the movements of the day, in the rutted dance ring between the wigwam of the Grand Chief and the grand wigwam. The dance by the captains was a sometime war medicine dance, before the fray, rendering the dancer impervious to arrow or to shot. This is a war victory dance, for all, men, women, and children. They dance around the circle, one following the other, the step a fast clog, the rhythm given by a man standing at the center beating with a little pine stick upon folds of what should be birch-bark but is brown paper. At the pauses in his song refrain the dancers halt and shout, that is, the six or seven young men and the one old man; the women do not shout, neither the middle-aged woman wearing the long, full skirt called Indian, but once copied, I am guessing, from a French peasant, nor the giggling young girl in high heels and close short skirt, Paris style by way of Sydney. And in silence dances the very little boy, who alone of them all takes an entirely serious view of the performance, stepping not only with spirit but without consciousness of the delighted attention he attracts. With much laughter and shoving others are urged to fall in, but hold back, including Ina Claire, although the Grand Chief himself offers to hold her prayer-book for her.

THE STEINHART AQUARIUM OF THE CALIFORNIA ACADEMY OF SCIENCES[1]

By Director BARTON WARREN EVERMANN
CALIFORNIA ACADEMY OF SCIENCES

On a sweet day in June, 45 years ago, a young college professor of zoology and a young student of his sat together on the bank of the Cumberland River just below the beautiful Cumberland Falls. The sun shone on the spray, and a rainbow arched the chasm which the river had cut. Beautiful climbing ferns, sensitive briars, orchids and magnolias covered the almost vertical walls that hemmed the river in.

The professor and his pupil saw all these, but they, for the moment, were chiefly interested in a small fish which the student had caught. The professor was giving his student his first lesson in systematic ichthyology. By means of a "Manual of Vertebrates," which the professor had recently written, and which contained descriptions of all the mammals, birds, reptiles and fishes then known from the eastern United States, the little fish was soon identified as the common stone-roller or dough-belly, whose scientific name is *Campostoma anomalum*; "anomalum," because its very long intestine is wound around its air-bladder, like the wire or string around a leaky garden hose to keep it from bursting—a structure quite "anomalous" among fishes.

In the weeks that followed, while tramping southward through Kentucky, Tennessee, North Carolina and Georgia, across the Cumberland Mountains and the Great Smokies, the professor and his student had frequent opportunity to take a look at the fishes in the streams they crossed. They sat on the banks of many of them—as the French Broad, the Swannanoa, the Tallulah and the Tugaloo, and studied and identified such fishes as they had caught. And thus the student's interest in fishes grew day by day.

Since those glorious days, the professor and his student have fished together in many waters, both fresh and salt, and in many lands. They have caught fish, usually while fishing together, in every state and territory in the Union, and in some foreign countries. They, sometimes alone, sometimes with others helping them, have waded a hundred miles or more, in rivers, lakes and along ocean shores, through which they dragged nets with which to catch the fish.

[1] Address given at the dedication and formal opening September 29, 1923.

STEINHART AQUARIUM

Sometimes the "water was fine" and felt very pleasant; sometimes it was very cold and felt very different; but it was always *wet!* One occasion is recalled when they fished in a certain icy-cold river in Colorado whose name is Rio de las Animas Perdidas, or the River of the Lost Souls.

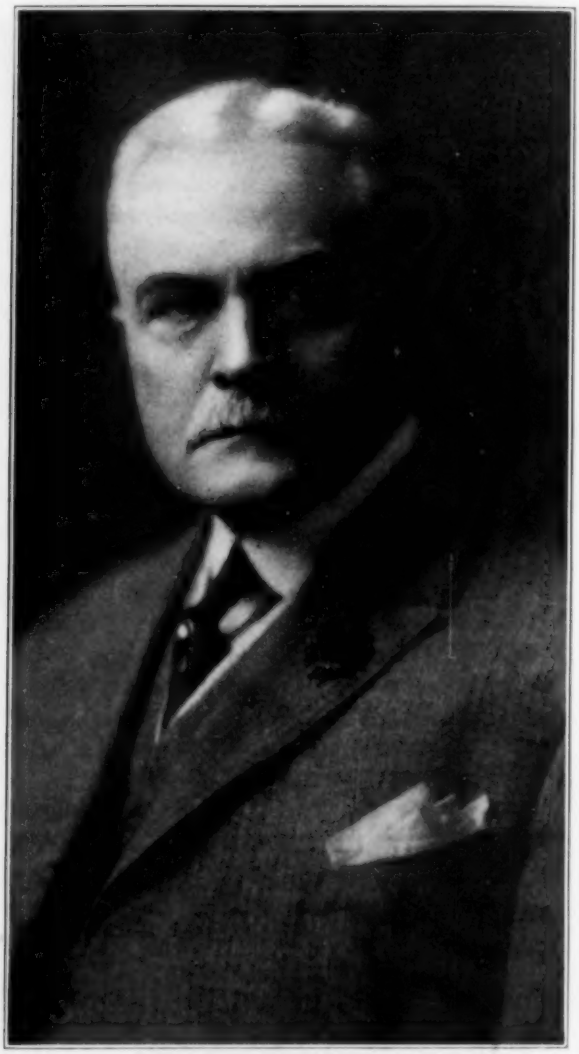
After a hasty inspection the professor decided that the best place to draw the seine was on a gently sloping gravel bar on the opposite side of the river, and said, "We will wade across and try it over there." There was a bridge only a few yards above us, and the three other members of the party said, "Why not cross on the bridge?" But, despite their protest, the professor gathered up one end of the seine, Davis the center, Fesler the other end, the other the collecting bucket, and we all started across, stepping from stone to stone where the water was deep. Soon the professor slipped and went in over his head! Scrambling back to shore as best he could, he remarked, between shivers, "I always thought that the place where lost souls went was a good deal hotter than this place is." We all then went up and crossed on the bridge.

On another occasion we went from Salt Lake City down into the Land of Juab where we fished the Sevier River. The professor had inadvertently left his seining clothes at the hotel, so he said, "You boys can do the seining to-day; I'll stay on the bank and boss the job and examine the catch as you bring it ashore." Fishes of several very interesting kinds proved abundant, and the professor became greatly excited. He disappeared for a moment in the bushes, but soon reappeared garbed only in a hat and a long linen duster, with the remark, "This is great! I want to share the fun with you boys."

We got many kinds of fishes in that interesting stream, and, as we drove back to Juab in the cool of the evening, we commemorated the event by fabricating and singing a "round" (a parody on "The Animal Fair"), which ran something like this:

We went to the fisheries fair,
The suckers and chubs were there;
And old Cottus blob with a red corn cob
Was combing the bullfrog's hair.
Pantosteus he got drunk
And fell on Agosia's trunk,
Rhinichthys sneezed
And fell on his knees,
And that was the end
Of the Blob,
blob,
blob.

With these many years of intimate association with Dr. David



BARTON WARREN EVERMANN
DIRECTOR OF THE STEINHART AQUARIUM

Starr Jordan in the study of fishes, it was quite natural that I, his student, should develop an interest in live fishes as well as fishes preserved in alcohol. So, in 1916, when some one told me that Mr. Ignatz Steinhart, a public-spirited citizen of San Francisco, was also interested in fishes and aquariums, I determined to meet him.

Through a mutual friend, the late Rudolph J. Taussig, I first met Mr. Steinhart on March 8, 1916. Mr. Steinhart spoke freely

IGNATZ STEINHART
FOUNDER OF THE STEINHART AQUARIUM

of his long interest in public aquariums and the interest of his brother Sigmund Steinhart; how he had dreamed for years of establishing a public aquarium in San Francisco; how he had visited all the aquariums in America and Europe; how he had employed experts to study aquarium problems and assemble data for him; how he had made propositions to various individuals and organizations to join him in the undertaking; how he had met with

A PORTION OF THE SWAMP ROOM IN THE STEINHART AQUARIUM

one difficulty and rebuff after another, until finally he had become so discouraged that he abandoned the idea entirely and decided to devote his money to an entirely different purpose. His decision seemed to be final; and I left Mr. Steinhart that evening with the feeling that there was no hope that he would ever put any money into an aquarium.

Two days later Mr. Steinhart phoned me to come and take luncheon with him at the California Market. I did so and he at once said that he had been thinking about the aquarium matter and wished to ask some questions, particularly as to the amount of money that would be necessary to provide an adequate building adequately equipped, what should be the scope and character of the aquarium, the best location, under what management it should be placed, who should provide the funds for maintenance, and many other details.

Among other things I told him about the great New York Aquarium which was established by the City of New York, the management of which was soon transferred to the New York Zoological Society, a private corporation.

To make a long story short, other conferences followed at brief intervals, and on April 5 Mr. Steinhart told me he had decided to provide an aquarium, provided it could be located in Golden Gate Park and placed under the management of the California Academy

ANOTHER VIEW OF THE SWAMP IN THE STEINHART AQUARIUM
Note the artistic railing around the swamp

of Sciences, which I had assured him was essentially the same sort of an organization as the New York Zoological Society. He stated that he would put $75,000 to $100,000 into it and would leave in his will a similar amount for enlargement.

Among those who had much to do with Mr. Steinhart's reaching this decision was Mr. E. O. McCormick, vice-president of the Southern Pacific. On one occasion Mr. Steinhart and Mr. McCormick visited the park together to consider various sites, and Mr. McCormick then suggested essentially the site which the building now occupies. Mr. Leon Greenebaum, an intimate friend of Mr. Steinhart and an enthusiastic angler, also had much to do in giving Mr. Steinhart counsel and encouragement.

On September 21, at a luncheon at the Palace Hotel at which Mr. McCormick presided, Mr. Steinhart made the first public announcement of his intention to provide the funds for an adequate building adequately equipped, provided (1) that the aquarium be located in Golden Gate Park, (2) that it be under the management of the California Academy of Sciences, and (3) that the city of San Francisco or some other institution supply the funds for maintenance.

From that moment the matter moved rapidly—the adoption of a charter amendment authorizing the board of supervisors to ap-

THE SWAMP ROOM OF THE STEINHART AQUARIUM

It is approximately 58 feet by 60 feet. In the center of the room is a swamp 24 by 40 feet, in which are shown many species of aquatic animals, including alligators, frogs, turtles, salamanders and water snakes; also aquatic plants. Around the swamp are two series of balanced aquariums which are very attractive and interest the public greatly.

propriate funds for the maintenance of an aquarium, Mr. Steinhart's intention to begin construction work early in 1917, his sudden death May 15, 1917, and the announcement that he had left in his will $250,000 to the California Academy of Sciences for an aquarium building and its equipment.

The executors paid the $250,000 to the Academy December 17, 1919. Immediately thereafter the architect's engineer, Mr. Trygve Ronneberg, and I went east and visited all the aquariums in America, and in the summer following I visited that at Honolulu. The knowledge gained from a study of these aquariums was of great value in our planning of the Steinhart aquarium. When the $250,000 was paid to the Academy (December 17, 1919) building conditions were not good, so the trustees loaned the money at a good rate of interest payable monthly. Whenever a monthly interest payment was received government certificates were bought with it. As a result something near $55,000 in interest has now been received, and we have put $305,000 instead of $250,000 into the building and its equipment. Building operations began April 1, 1922, and you now see the building practically completed.

In certain features the Steinhart Aquarium is the most complete and satisfactory of any in this country.

We have four kinds of water—fresh water of the local temperature for local freshwater fishes and similar species; fresh water cooled to meet the needs of trout, salmon and other cold water species; salt water of the local temperature for local and other salt-water species suited to that temperature; and salt water warmed to meet the needs of fishes from the Hawaiian Islands and elsewhere in the tropics.

There will be upwards of 110 tanks, large and small, and large outdoor pools. One unique feature is a large indoor tropical swamp stocked with various species of turtles, frogs, water snakes, salamanders, alligators and aquatic plants. Around the tropical swamp are two series of balanced aquariums which are very beautiful and interesting.

Another unique feature is a fish-hatching equipment where an expert detailed by the State Fish and Game Commission will demonstrate the methods of fish culture. Still another unique feature is a well-equipped biological laboratory in which college professors, high school teachers, students and others can carry on investigations of any problems of aquatic life that can be studied from aquarium material. It is expected that this laboratory will prove of real value to the public schools.

The aquarium employs what is known as the closed circulation system; the water being stored in large reservoirs from which it is

kept circulating through the aquariums, the same water being used over and over again for years.

The object has been to carry out the wishes of Mr. Steinhart by providing an aquarium that will be of the broadest general interest and that will be of the highest educational value to the city and the state. To what extent this aim has been realized you can judge when you enter the aquarium.

The staff has now been selected and the aquarium is in operation. We are fortunate in having secured as superintendent in immediate charge of the aquarium Mr. Alvin Seale, who built the Manila aquarium, which he operated for several years. As principal expert assistants to Superintendent Seale we have secured Mr. H. Walton Clark, for many years connected with the United States Bureau of Fisheries, and Mr. Wallace Adams, as assistant superintendent.

That this occasion is a very happy one for me may well be believed. It marks the realization of an ambition that has possessed my soul for many years. And I can repeat what I have often heard Dr. Jordan repeat from good old Izaak Walton: "It is good luck to any man to be on the good side of the man who knows fish." And I may add, it is good fortune for any man to have "walked with Jordan," and doubly blest is he who has *fished* with Jordan.

And as we are assembled here to-day, my thoughts go back to that delicious day at Cumberland Falls 45 years ago. The wax was soft then and the impress grew indelible. I see again the whole scene—the great silvery waterfall, the broad sheets of white and green water pouring over the precipice to lose themselves in the swish and swirl of the great cauldron at the base; the spray filling the gorge, the spray-washed and diamond-studded ferns and moss and shrubs on the walls, the gorgeous masses of flowers, the mist rising above the gorge and gleaming in the sunlight, and the rainbow arching all.

The professor and his pupil sit together here again to-day. In imagination they have reached the rainbow's end, and they have found, not the mythical pot of gold, but something of vastly greater interest and value to you and me and all the people of California—this beautiful aquarium, this splendid enduring memorial to Ignatz Steinhart, erected, in the felicitous words of the donor, "for the benefit of the inhabitants of San Francisco and others who may enjoy said aquarium and derive knowledge and information therefrom."

Would that Mr. Steinhart could be with us here to-day and enjoy with you and me and all of us, and that all of us might enjoy with him, the fruition of his dream.

ALCOHOL FROM A SCIENTIFIC POINT OF VIEW

III. The Defenses of the Body against Alcohol

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Introduction

In a former paper[1] we have referred to the early writings of Arnoldo de Villeneuva (1309) in which he extolled the spirit of wine, attributing to it the prolongation of life. Since the time of Villeneuva mankind has had no little experience with alcohol and should, in a way, be able to offer expert opinion; for the mind of practically every man has been confronted by Villeneuva's conclusion. From a scientific point of view as well as from a general point of view a part of the question, at least, has been answered; that part has to do with alcohol in excess. In excess alcohol is universally held to be injurious. In large doses as we have already seen[2] it is a poison abundantly able to cause death; and in somewhat smaller dosage it may produce chronic alcoholism which may eventually result in the death of the organism.

As for alcohol in moderation some men of to-day accept the dictum of Villeneuva. Others speak more cautiously of "its possible benefit, particularly in advanced life."[3] In order to determine whether alcohol in moderation is or is not beneficial to man it is necessary to look into the general question of the destiny of alcohol in the body. This question may well be divided into two parts. One of these has to do with the action of the alcohol on the body; the other pertains to the defenses of the body against the alcohol. I should like to consider the latter question first, reserving the former for a future discussion.

Defenses of the Body against Alcohol

We have indicated that against excessive doses the body is without sufficient defenses. To review the struggle made in acute alcoholic poisoning or in chronic delirium would be to draw a picture neither pleasant to behold nor profitable for our present consideration. Below the killing or lethal dose, however, the defenses of the body may be studied with profit.

[1] *Pop. Sci. Mo.*, p. 567, June, 1913.
[2] *Pop. Sci. Mo.*, p. 550, Dec., 1913.
[3] Howell: Text-book of Physiology, 1921, p. 929.

Summarily, it is known that when alcohol comes into contact with the mucous lining of the mouth there follows almost instantly a heavy flow of digestive fluids which tend to dilute the alcohol. Again, alcohol is readily absorbed into and greatly diluted by the blood stream. The magnitude of the dilution by the blood is made evident when we find that the alcoholic content of the blood, even in acute intoxication, rarely exceeds one half of one per cent. Further, in the blood stream alcohol is subjected to the most potent of all the defenses of the body, that of oxidation, by which it is destroyed. But, unfortunately, when alcohol gains access to the blood stream it also is on the highway to all the tissues of the body. While some of these are little affected by alcohol, others, like nervous tissue, are susceptible to it even in low concentration.

Secretion as a Defense

Following the ingestion of alcohol two distinct phases of secretion may be noted: First, following a heavy dose mucus may be formed and the actual amount of secretion reduced; secondly, after a moderate dose salivary secretion is increased; in fact, an increase is brought about simply by retaining alcohol in contact with the mucous lining of the mouth. From a moderate dose of alcohol gastric juice may be practically doubled. This increased output of gastric secretion proves to be a defense of considerable importance against the alcohol, but gastric juice thus formed is of inferior quality for digestion. While a normal amount of hydrochloric acid is secreted a deficiency in pepsin, the enzyme of gastric digestion, occurs. It has been found that if 5 to 10 per cent. alcohol be taken the pepsin already formed in the cells is washed out, and further pepsin is not produced in the presence of the alcohol.

While the various kinds of secretions dilute the alcohol to a considerable degree, yet secretions are to be regarded as of relatively minor importance as defense for the body.

Distribution of Alcohol by the Blood

Rate of Absorption from Digestive Tract

To the general question What becomes of alcohol ingested? we may answer that it is readily taken from the digestive tract into the blood stream. Mellanby[4] has shown that usually within an hour after ingestion a maximum concentration of alcohol appears in the blood. That is, if 20, 30, 40 or even 50 cubic centimeters of pure alcohol be diluted to 20 per cent. and given by stomach to a dog the alcoholic content in the blood will reach maximum concentration at about the same time for any of these amounts.

[4] Rept. No. 31, 1919, Med. Research Com., London.

The above statement is true provided the amounts be given at the same percentage, in this case 20 per cent. If given at a lower percentage, for example, 3 per cent., the alcohol will be taken into the blood stream more slowly. This is due principally to the fact that a relatively large volume of water has to be carried in with the lower percentage. As an example, for 30 cc of pure alcohol at 3 per cent. to enter the blood would necessitate the absorption of 1000 cc (nearly a quart) of fluid. On the other hand, for 30 cc at 20 per cent. to enter would involve the absorption of only 150 cubic centimeters.

In certain beverages, however, it appears not to be a matter simply of dilution. For example, English stout is absorbed into the blood at a relatively slow rate, the maximum concentration being reached only after two or three hours. That dilution is not the only factor here involved is made certain by comparing its rate of absorption with that of whisky diluted to the strength of stout. In such a comparison the alcohol of whisky at the same dilution is absorbed more rapidly than that of stout.

Effect of Food on Rate of Absorption

It is common knowledge that alcohol on an empty stomach acts with greater speed and greater violence than it does in a condition of satiety. This difference in action is assumed to mean that it is readily absorbed in the former case, while in the latter it becomes mixed in with the food, and its absorption is delayed until the digesting substances are themselves absorbed.

To test the effects of food on the rate of absorption of alcohol Mellanby gave alcohol with a diet of milk and bread. He found that the rate of appearance of maximum concentration of alcohol in the blood was considerably impeded. Indeed, the retardation in absorption could be produced with milk alone. That this retardation is not due solely to the factor of dilution is shown by the fact that the effect is greater than would be produced by simple dilution of alcohol, and that the effect appears in the blood apparently after fluids have been absorbed. Further than this, he has shown that with separated or skimmed milk little retardation in absorption occurs. The delay is marked, therefore, only in milk which contains butter fat. We assume that this delay is accomplished as in certain other cases in normal nutrition where the passage of fats from the stomach to the intestine for some reason is retarded.

Shall we speak of butter fat and the inhibiting substance noted in stout as defenses of the body? These substances are no part or possession of the body; that is, they are not increased by it, and consequently act to its advantage only in an indirect way.

Effect of Water on Rate of Absorption

If alcohol be taken with water the effects of dilution above discussed appear. If, however, water be given and allowed a sufficient time, two to four hours, to be absorbed before the alcohol is ingested, then the alcohol enters the blood stream at a perceptibly greater rate even than on an empty stomach.

From the above considerations it appears that alcohol of considerable concentration in the digestive tract has its strength greatly decreased by its rapid distribution in a relatively large volume of blood. This is a strong defense for the digestive tract; further, it equalizes the effect on the blood vessels in general. But all that can be said for the defenses of secretion and distribution is that they thin the alcohol out. The total amount of alcohol ingested might remain in the body following these processes were it not for other potent defenses.

Disappearance of Alcohol from the Body

Although alcohol enters the blood stream rapidly it disappears from it relatively slowly. What are the factors involved in its disappearance? What are the defenses employed by the body to this end?

In answer to the question—How does the body rid itself of alcohol?—the early French scientist, Royer-Collar (1839), gave answer through experiment that the body eliminates it through the respiratory tract "unchanged." But Royer-Collar and all other workers who have obtained considerable amounts of alcohol eliminated unchanged were dealing with it in excess. In such overdoses at least two ways of removing the alcohol unchanged are open to the body. A part may be eliminated through the lungs, and a larger part may be removed through the kidneys. It has been estimated that as much as 10 to 12 per cent. of the total amount ingested in excess may thus be eliminated.

How does the Body destroy Alcohol?

It has been known for a long time that alcohol outside of the body will burn, producing a certain number of calories of heat per gram; furthermore, it is known that as byproducts it yields carbon dioxide and water. If we assume that a similar process takes place within the body and that alcohol burns in addition to other foods, we might expect as tests of this internal oxidation (1) a rise of the body temperature, or (2) an increase in the output of carbon dioxide.

We know that one of the first characteristics accompanying the ingestion of alcohol is a "feeling of warmth." This apparent

warmth, however, does not necessarily mean an increase in body temperature; on the contrary, under such a condition the body temperature may suffer severe depression. Indeed, some of the lowest temperatures recorded for the human species were taken at the time of alcoholic delirium of subjects exposed to low surrounding temperatures.

As to the output of carbon dioxide as an indication that the body burns alcohol, we may summarily say that the output of CO_2 upon the ingestion of alcohol is often decreased rather than increased; but this fact alone is by no means conclusive proof that the body can not oxidize alcohol. For as Howell (p. 931) has said, if the alcohol be destroyed in the body in place of an isodynamic amount of sugar or fat a lowering of the output of CO_2 might be expected. This is shown by the fact that if *one* gram of alcohol is burnt it produces 1.91 gr. of CO_2; while 1.7 gr. of sugar (an isodynamic amount) similarly burnt produces 2.77 gr. of CO_2; and .75 gr. of fat (also an isodynamic amount for one gram of alcohol) gives 2.13 gr. of CO_2. This is the same as saying that if the alcohol oxidized contains less carbon than the material which it replaces, that is, carbohydrates or fats, less CO_2 will result. If, on the other hand, the alcohol be burnt in addition to the amount of other material burnt at that time, then more CO_2 would be produced with the alcohol than without it.

Bouchardas and Sandras (1846) were among the first to conclude that alcohol may be actually burnt in the body. Following their experiments came the confirmatory work of Liebig in Germany and of Ducheck in Russia (1853). As a result of the studies of that period scientific men were in agreement that alcohol could be burnt in the body and its energy used as the energy from other foods is used. But how far this is true has been determined only in part even at the present time.

Recent Experiments on Oxidation of Alcohol in the Body

It may be said without reserve that the experiments of Atwater and Benedict[5] constitute one of the most brilliant series of studies yet made on alcohol. These experiments are so far-reaching in importance as to justify more extended consideration at this time.

Atwater and Benedict used a respiration calorimeter which was sufficiently large to house a man in comparative comfort for a period of days and which was sufficiently sensitive to detect and measure the products of oxidation in the respiratory current even in small quantities. To test the accuracy of the calorimeter known quantities of heat were generated electrically inside the chamber.

[5] Memoirs Nat. Acad. Sci., Vol. 8.

The calorimeter was thus shown to register accurately the amount of heat given off. To test it also as a respiration calorimeter a known amount of alcohol was burnt inside the apparatus and the amount of water, carbon dioxide and heat measured. This tested it as a respiratory apparatus and also as a calorimeter.

The first problem tested was how much of the alcohol ingested is burnt. The details of the experiments were somewhat as follows: Men, some unaccustomed to the use of alcohol and others accustomed to it, were subjects of experimentation. One of these, after undergoing a preliminary experiment outside of the calorimeter to become accustomed to a prescribed ration, entered the respiration calorimeter and repeated the diet for a similar number of days. The normal diet consisted of protein, carbohydrate and fat, and to this sometimes was added (or substituted for a part of it) a definite amount of alcohol.

This amount consisted of a daily ration of 72 gr. (2½ oz.) of absolute alcohol divided into six doses. Three of these doses were taken at meal time, two between meals and one upon retiring. The doses not taken with meals were immediately followed by 200 cc of water. The amount of alcohol taken per day, as the authors suggested, was about equal to that in a single bottle of claret similarly taken in six doses. The immediate effect of such a dose was so slight as practically not to affect the nervous system. This was made evident by the fact that only one of the men studied experienced any effect and that was only a slight ringing in the ears.

Proof that Alcohol is Burnt in the Body

Perhaps it should be further emphasized that the dose of alcohol studied was small (less than one half ounce at a dose). The purpose of so small a dose obviously was to prevent its secondary action as a drug. The amount which was oxidized was taken to be the difference between the amount ingested and that given off unchanged. Amounts of alcohol in the exhaled air and in the urine were determined, and only 2 per cent. of the total amount taken was eliminated. In other words in small quantities 98 per cent. of the alcohol ingested was burnt. This was especially interesting when 5 per cent. of fats and 7 per cent. of the proteins were eliminated unoxidized.

Recently Mellanby[6] has conducted a series of experiments which add to our knowledge of the oxidation of larger doses of alcohol. In this series it was found that after alcohol has reached its maximum concentration it disappears from the blood with great regularity but at a remarkably slow rate. In a dog of 13.5 kilograms weight it took 20 hours for 50 cc of alcohol to leave the blood; that

[6] *Loc. cit.*

is, about 2½ cc were burnt per hour, giving a rate of oxidation of 0.185 cc per kilogram per hour.

In the experiments of Mellanby the maximum concentration mounts considerably above 354 cmm, which is at the threshold of intoxication. Despite this fact, the plane of oxidation is relatively regular.

From experiments like the above we may confidently conclude that the body is able to oxidize alcohol. A further question is: Can the body use the energy of oxidation? If so, in what way can it use it?

Substitution of Alcohol for Food Substances

Hammond early observed (1856) that users of alcoholic drinks often gain in body weight. His interpretation of the phenomenon was that alcohol retards metamorphosis of old tissue, promoting the formation of new, and limiting the consumption of fat. That the body may use and, as a consequence, limit the consumption of fat is, as we shall see later, shown by experiment; but that alcohol which possesses no nitrogen can not enter into the formation of new tissue is equally well established. In general, then, the phenomenon of increase in body weight was early interpreted to mean that the tissues of the body in some way protected themselves at the expense of the alcohol. Alcohol hence became spoken of as a preventer of waste or a conserver of tissues. Now it is quite certain that if alcohol conserve the tissues, preventing their consumption, this might be done in one of two ways: First, the alcohol might act as a drug to prevent the tissues from being used up; or secondly, it might prevent the destruction of the tissues by being used in their place. It is evident that whether it act in the one way or in the other the same outward result would follow, that is, the body would gain in corpulence.

Atwater and Benedict sought to find out in how far the body can utilize alcohol as a substitute for other food substances. That is, to what extent can alcohol be used in the place of the fat, thus allowing the fat to be stored up or "spared"? To test this question a diet of protein, fat and carbohydrate was given to which was added an amount of alcohol. As a result of this ration less carbon was eliminated from the body, showing that fats or carbohydrates or both had in some way been spared combustion. Following this experiment alcohol was substituted in the following way for an isodynamic amount of fat or of carbohydrate. A given diet was selected in which the actual heat value of the food, if the food had been burnt outside of the body, was known to be 2,500 calories. Now 500 calories in potential alcohol was substituted in place, say, of an isodynamic amount of fat or of carbohydrate. In all such cases the normal heat output for the expected amount (2,500 calo-

ries) was realized, showing that the alcohol had been converted into energy in place of the substances for which it had been substituted. From this series of experiments it is shown that alcohol may be substituted for food substances, thus sparing these substances and allowing them to be stored.

Energy from Alcohol used in Work

While the experiments of Atwater and Benedict were planned primarily to test whether or not the body can convert alcohol into heat, the experiments give suggestive data on the production of muscular activity when alcohol is the source of the energy. In the series to test the utilization of the energy of the alcohol in work two types of experiments were made. One of these was the so-called rest experiment. In the other experiment hard muscular work was done. As to the rest experiment it is of course known that a great amount of internal work, as, for example, heart beat, respiration and the like is constantly being done by the body. The work experiments were in general similar to the rest experiments, excepting that the subject put in eight hours a day on a stationary bicycle. This bicycle was attached to a dynamo so that the work done could be measured in terms of heat produced. The heat resulting as muscular work on the pedals was converted into electrical energy which was led through an electric lamp and measured in heat units. In addition there was produced frictional heat. We may first give the plan of an experiment in the production of heat energy comparing an alcoholic and a non-alcoholic diet, giving at first the so-called rest experiments. The average of thirteen such experiments follows:

Rest experiments	Energy in calories of food taken per day	Energy in calories reclaimed per day
Without alcohol	2718	2723
With alcohol	2746	2752

The intake in each case was practically equal to the output, and the alcohol was apparently used as well as the other foods in producing energy. The energy which was latent or potent in the alcohol was wholly transformed in the body, it was actually given off from the body, and further it was actually recovered as heat.

In the work experiments almost a thousand calories more were needed than in the rest experiments. But of these 500 calories in alcohol were substituted. That the alcohol was burnt to form the energy is indicated by the following experiments:

Work experiments	Energy in calories of food taken per day	Energy in calories reclaimed per day
Without alcohol	3668	3671
With alcohol	3698	3676

In the rest experiments above, almost one fifth of the energy (heat) formed came from the alcohol (total energy of daily diet 2,700 calories; 512 calories, energy in alcohol); while in the work experiments at least one seventh to one eighth resulted from the burning of the alcohol (total food value, about 3,700 calories; 512 calories in alcohol).

These experiments demonstrate that the body in health can by oxidation convert alcohol into energy, that it is capable of substituting a small amount of alcohol for other food ingredients; further, the experiments strongly indicate that the energy formed from small amounts of alcohol can be used in work. But it should be emphasized that further than this Atwater and Benedict do not go. They say:[7]

> It should not be forgotten that the desirability of alcohol as part of a diet for muscular work is not decided by the narrower questions here discussed. There is a very decided difference between the transformation of the potential energy of alcohol into the mechanical energy of muscular work and the advantage or disadvantage of alcohol in the diet of people engaged in muscular labor. Even in the small doses in these experiments there were indications that the subjects worked to slightly better advantage with the ordinary rations than with the alcohol. The results of practical tests on a large scale elsewhere coincide with those of general observation in implying that the use of any considerable quantity of alcoholic beverages as part of the diet for muscular labor is generally of doubtful value and often positively injurious. Aside from the question of the power of alcohol to protect protein and fat and supply energy to the body for various useful purposes there are the far weightier considerations of the general effect of alcohol upon the muscular and especially upon the nervous system, and upon health and welfare. Upon these serious hygienic, economical and ethical problems the experiments here recorded throw no special light.

Perhaps we are now in a position to inquire more specifically: Can the body use the energy of alcohol as it would utilize the energy derived from the oxidation of foods in general?

We recognize two services performed by foods: (1) They may build up living protoplasm, and (2) they supply energy. Certain foods, the proteins, can build up protoplasm and can produce energy which may either be stored for future use or used immediately; other foods, the carbohydrates and fats, while unable to repair protoplasm, can produce energy to be stored for the future or to be made immediate use of. Alcohol can not repair protoplasm; neither can it produce energy to be stored for future use. Its use as a food is restricted to the production of energy, which may be made immediate use of. Further, it should be noted that its employment as a fuel to be made immediate use of is conditioned by the amount which can be used without disturbing the nervous balance. Beyond this amount alcohol acts as a drug and as such can not be said to have the same valid nutritive qualities.

[7] Memoirs, Nat. Acad. Sci., Vol. 8, p. 284.

GEOLOGY AND OUR CIVILIZATION

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AT this time, when all things in life are being scrutinized and even values are undergoing revaluation, when new standards are being set and some old ones discarded, when some gods whom we formerly worshipped are found to have cloven feet, and disillusionment makes many people doubt all things, when new definitions of culture and education are being given, the writer has thought it might be of no little interest and perhaps of value to present the brief for his chosen profession—not that its claims to recognition particularly need a champion, certainly not in the commercial field, but rather because its place in the general scheme of a higher culture is not as clear to the layman as it is to those who know the profession.

And right here the temptation can not be resisted to launch one Parthian arrow about this matter of culture. Many people are under the delusion that culture consists in the quoting of fine phrases, particularly in a foreign language. Culture is not restricted to the field of the humanities. Real culture consists in a liberal education (which of course, must not leave out the humanities) and gentleness of spirit, as Galsworthy puts it. This last is of far greater importance than either the classics or science, the late demented Nietzsche notwithstanding.

In these latter days some of the superficially minded are sending up a smoke screen (principally to hide their own shortcomings) at all things classical, and it has become the fashion to speak of geology as "earth science." Why do they object to the term geology and still use geography? And so, for the sake of those who have been led astray and have deliberately cut themselves off from partaking of the world of thought represented by the classical school, who find Latin and Greek merely encumbrances, forgetting their really great "practical" worth, we shall say that this discourse deals with earth science, or, rather, some phases of it. All science, for that matter, is earth science, even though it attempt to explain the Milky Way.

Man's dwelling-place, as far as we know, has always been the earth, and for eons to come may continue to be, and yet how few people know anything about our habitation! It is a trite saying that we all come out of the soil and in a brief time go back to it. This was the song of the Psalmist of old, of Omar and of preachers

throughout the ages. Before the coming of the balloon and the airplane the farthest any one by his own efforts could get away from earth was about six feet. And still on we go, generations and generations, not knowing our own dwelling-place, whence we came, whither we go or why. Most of us are simply "on our way."

> Into this Universe, and Why not knowing
> Nor whence, like Water willy-nilly flowing
> And out of it, as Wind along the Waste,
> I know not whither, willy-nilly blowing.
>
> A moment's Halt, a momentary taste
> Of Being from the Well amid the Waste
> And lo!—the phantom Caravan has reached
> The Nothing it set out from—Oh, make haste!

How utterly false this philosophy is we hope to show in later pages. The Rubaiyat is a beautifully sounding poem, but poor philosophy. It speaks to the flesh, not to the soul.

The perverseness of man in persisting in living on the slopes of volcanoes, on hurricane-swept coasts, or over dangerous fault cracks has always been a mystery to the writer, but still man does it and disasters come and come again in spite of prayers and signs made across the breast. With all the Sodoms and Gomorrahs, Pompeiis, Messinas and Galvestons, the average man *will* not learn from his experience.

The struggle of life among many people still goes on much as does a complicated game essayed by beginners who have not even taken the trouble to learn the rules of play. This thought has been so well put by the great champion of Darwin in his essay on "What is a Liberal Education?" that we are loath to pass on without quoting a few lines:

> And by way of beginning, let us ask ourselves, What is education? Above all things, What is our ideal of a thoroughly liberal education?—of that education which, if we could begin life again, we would give ourselves—of that education which, if we could mould the fates to our own will, we would give our children? Well, I know not what may be your conceptions upon this matter, but I will tell you mine, and I hope I shall find that our views are not very discrepant.
>
> Suppose it were perfectly certain that the life and fortune of every one of us would, one day or other, depend on his winning or losing a game at chess. Don't you think that we should all consider it to be a primary duty to learn at least the names and moves of the pieces; to have a notion of a gambit, and a keen eye for all the means of giving and getting out of check? Do you not think that we should look with disapprobation amounting to scorn upon the father who allowed his son, or the state which allowed its members, to grow up without knowing a pawn from a knight?
>
> Yet it is a very plain and elementary truth that in life the fortune and the happiness of every one of us, and, more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infi-

nitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chess-board is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of Nature. The player on the other side is hidden from us. We know that his play is always fair, just, and patient. But we also know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well, the highest stakes are paid, with that sort of overflowing generosity with which the strong shows delight in strength. And one who plays ill is checkmated—without haste, but without remorse.

My metaphor will remind some of you of the famous picture in which Retzsch has depicted Satan playing at chess with a man for his soul. Substitute for the mocking fiend in that picture a calm, strong angel who is playing for love, as we say, and would rather lose than win—and I should accept it as an image of human life.

Well, what I mean by education is learning the rules of this mighty game. In other words, education is the instruction of the intellect in the laws of Nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. For me, education means neither more or less than this. Anything which professes to call itself education must be tried by this standard, and if it fails to stand the test, I will not call it education, whatever may be the force of authority, or of numbers, upon the other side.

There we have the whole thing—"the rules of the game"—oh, if we only knew and would observe them, so many, many lives would not be checkmated so early! Because he has not learned the rules of the game the savage is disappearing, cities are brought low, ships full of costly treasure sink beneath the waves, civilizations disappear, and untold and unnecessary anguish pervades many fair spots of the globe. Some peoples there are, like the Chinese, who by their breeding powers and ability to subsist cheaply cheat, as far as the race is concerned, the player on the other side of the table, but for most it means in the end extinction.

In this connection the writer begs leave to comment on some recent utterances of Professor John Dewey, the philosopher, a *griffin*[1] in affairs of the Far East, who writes as follows:

It helps to explain the conservatism of the Chinese, their *laissez-faire* reverence for nature and their contempt for hurried and artificial devices of man's contriving. Their minds are as steeped in contact with natural processes as their bodies are apt for agricultural work. They are conservative because for thousands of years they have been conserving the resources of nature, nursing, preserving, patiently, obstinately. While Western peoples have attached, exploited and in the end wasted the soil, they have conserved it. The results are engraved upon both Chinese and western psychologies. The Chinese have learned to wait for the fruition of slow natural processes. They can not be hustled because in their mode of life nature can not be hustled. Why be in a hurry when hurry means only vexation for yourself and either accomplishes nothing in nature or else interferes with its processes and so hinders the natural harvest? . . .

[1] A new horse running its first race.

The Chinese have almost more than any other people *wasted* their natural resources, particularly forests. As for their contempt for artificial devices, etc., what about the Chinese method of renitrifying the soil and rotation of crops, their coal briquets, etc.? Perchance Dr. Dewey has never read King's "Farmers of Forty Centuries." They do *just the things* he says they do not do. The present writer has great admiration for the Chinese, but he thinks their conservatism is carried too far. The world will never be improved by conservatives and fatalists.

As we are going to discuss geology in its relation to our present civilization, or we may say just civilization, it behooves us to define civilization. Not long since I saw a book, one of those illogical things the author of which adopts a sensational title to help "get it over" with the public; the title was "Civilization, Its Cause and Its Cure." To one who has seen the life of primitive peoples, civilization is not a disease and man is infinitely better off under so-called civilized conditions than under the conditions of savagery. While our civilization has many faults and is only one of many admirable civilizations, it is the opposite of savagery. It is that kind of life which is so ordered for the race as a whole that there is time and opportunity left over after the business of getting food and keeping warm and begetting offspring for the things of the mind and of the spirit, for games, for politics and sermons. Savages play little or not at all, their politics are simple and there is little evidence of introspection.

Granted, at least for the time being, that we have a civilization, which is not perfect, to be sure, and yet not so bad, what is the rôle of geology in that civilization? Well, in the first place, geology acquaints us with many of the "rules of the game" in nature. Physics and chemistry define them, but geology shows us how they have worked and are working to-day.

The three great basic industries, the tripod of our material well-being at least, are forestry, agriculture and mining. To this we might add fishing. There seems to be little question but that man studied forestry, in a crude way, of course, before he did either of the other two arts; next came agriculture, and last mining. In the earliest time he saw (and there was no need for him to) little relationship between geology, or the formations of rocks, and the forests, but to-day it is different. In my library is a book, a thick one, too, called "Forest Physiography," which, among many other interesting things, shows the relations between the character of the vegetation, types of trees, stand, etc., and the geologic formations. This is so important and large a subject that it is almost a separate and distinct science. There is such an intimate relationship that the writer has used the converse of this and mapped

geologic formations in certain places in the Philippines by noting the vegetation growing on them. In Surigao, Mindanao, Philippine Islands, on the very basic rocks whose weathering has yielded the extensive deposits of laterite, so rich in iron as to be classed as iron ore, the vegetation is peculiar and strikingly different from the rest of the lowland region. In eastern Oregon the valuable yellow pine forests grow on disintegrated basalt, while the pumice strewn stretches will support a growth of jack pine only.

Also in the Coast Range mountains of California, one can note a distinct change in vegetation between that growing on rocks of Franciscan (Jurassic) age and that on Cretaceous and Tertiary rocks, the change in many instances being quite sharp.

If, before buying a farm, you wanted to be perfectly sure of the kind of soil you had, you would naturally take samples to be analyzed. Much or little can be made out of these, depending upon how, when and where they are taken, but if you knew the simple geologic formations you could tell a great deal without resorting to the other method. Certain formations on weathering yield definite soil products, some good, others not so good. And, again, the drainage of the farm is an all-important factor, and even a rudimentary knowledge of the subject will tell you much. In the "good old days" before science was developed the farmer did not heed these relationships, but he can not afford to ignore them now. We in America pride ourselves on our agriculture, but a people (no other than the hated Germans) by scientific study of the soils have been able to increase the fertility of otherwise poor soils so that they get many more bushels per acre than our yield, and it might surprise a number of farmers to learn that "dry farming" has been practised on the Balearic Islands for hundreds of years. One of if not the most important commercial fertilizers is a geological product, the buried potash salt deposits of Alsace and Stassfurt and Wielicza. We, in America, are just beginning to utilize these soil replenishers.

Now when it comes to mining, the applications are too patent to need elaboration here. I may be pardoned for alluding here to the Benguet Consolidated Mine in the highlands of Luzon, one of the notable small gold mines of the world, but it will illustrate the connection, particularly since it shows the practical application of the work of the geologist. The prospects of that property in 1909, when it was wrecked by a typhoon and there was a question of whether or not it should be rehabilitated, depended upon determining three things: (1) What is the cause of its mineralization? (2) will the values continue in depth? and (3) to what depth? These things and others can be and were determined with a high degree of probability by a geological study of the region, and by

no other way, in advance of actual mining. The mining geologist has become an institution. How proud the profession is to-day of the achievements of the most eminent member of it! The writer is one with a goodly number who believes that when politics and social relations are studied scientifically then, and not till then, will confusion and blundering be displaced by peace and contentment. He is one, whether or not his views are shared by others, who believes that the particular type of training afforded by geology and engineering is greatly needed in the world to-day. The lawyers and preachers, professors and even the business men have had a turn and their work has been of value—but let us see what the engineer and the scientist can do. If they are given a chance, methinks a new era in politics will be upon us.

The rôle of the geologist in the great and fascinating oil game has been the theme of many magazine articles recently, and we hardly need to take the time now to repeat some of his exploits. Exactly what the oil geologist does when he is snooping around a supposed oil field, we shall not tell you now. Suffice it to say that he uses no magic, no incantations, but in their stead organized common sense, which is only another definition for science. Some people still find (or try to find) oil and water with divining rods, but concerns like the Standard Oil Company do not find that they can afford such wasteful and unscientific methods.

The writer has often told his classes in geology that if they knew all about the oil game they would have no difficulty in understanding much of the trouble between Mexico and the United States, and recently a professor of history told him, with tremendous enthusiasm, of a new way of writing history he had invented. He proposed to write history from the point of view of the great industries, such as oil, wheat, gold and other resources. I hope he will carry out his intention and if he does, it ought to be good history, too, because it will take into account the things that have made history, and we shall hear less of kings and politicians and heroes, and much buncombe will be got rid of. Lo! already we have the first of the new kind of histories—Wells's "The Outline of History." You will please note that in the "Outline" the writer goes back into geologic history, the only proper foundation for the understanding of human history.

There are besides these fundamental fields many activities of men which also are profoundly affected by geologic considerations, but these are not so evident as in the cases cited. The writer proposes to give a number of concrete cases which will, it is hoped, reveal the far-reaching effects born of a knowledge of this subject.

The first illustration is found in the field of engineering. Recently a railroad company was being sued by a firm of con-

tractors in an attempt to get a different classification of excavated material in the construction of a new line. With a different classification a higher rate of payment would have to be made. One of the main contentions of the plaintiffs was to the effect that a great body of material which had been classified as earth by the railroad engineer was shale, which would mean an additional payment of a good many hundreds of dollars. As a matter of fact—and the veriest tyro in the subject should have known it—there was no shale at all in that particular locality, it being *all adobe*, a stiff clay characteristic of the volcanic regions of the western United States. Most of the plaintiff's contentions were equally absurd, but for downright foolishness, the statement made by the "geologist," so called, to the effect that a certain body of material was "clay in the winter and shale in the summer" excels anything any freshman in our college classes has ever said.

Suppose I were going to engage in the business of foreign trade, would it not be a very necessary thing to know what foreign countries possessed in the way of raw materials and manufactures before investing too heavily in equipment? Raw materials are generally geologic products, and fuels are also very necessary and these, too, are geologic products, coal and oil being the most important. Whether it be petroleum or diamonds, bauxite or asbestos, copper or phosphates, tantalite or sulfur, one is dependent upon geology; that is to say, where, how they occur in the rocks, and in what quantity. This is commercial geology. Two notable books along this line have appeared recently which no statesman or student of world affairs can afford not to read. They are "Commercial Geology," by J. E. Spurr, former consulting geologist for the Guggenheim Syndicate, and "The Strategy of Minerals," by Dr. George Otis Smith, director of the U. S. Geologic Survey.

Much has been written about scenery, and the older geologies, which were largely descriptive, developed this side to the neglect of some things which are now given more space in the text-books. Nevertheless, it is scarcely an exaggeration to say that only one tourist in a hundred knows, much less appreciates, the history of the Yosemite Park region, the story of a bit of chalk from the white cliffs of northern France, the reason for the thousand and one little lakes in northern Wisconsin and Minnesota, or the full meaning of that chain of snow-capped peaks along the crest of the Cascades. That famous region between Austria and Italy known as the Dolomites is a land only of crazy, jagged rocks to many of that restless horde which, formerly at least, used to crawl like ants over and about those limestone pinnacles.

The human stream flows on from year to year over mountain and across plain, by glaciers and through oil fields, but little know

or care they about cirques, moraines, faults, anticlines or diatomaceous shales. The great teeming book of Nature is for them little more than a Gideon's Bible in a hotel bedroom. The trouble is this, that the average tourist is on his way—in a gas-driven buggy—and he cares more about arriving than about what is along the road.

Here is where geology, if given a chance, might and would wonderfully enrich the pleasure and profit of the traveller. The writer vigorously protests against the assertion of some artistic and temperamental individuals that they alone see the beauties of Nature, that the scientist with his "mania for knowing *why* kills the joy in the picture." There are some beauties in nature which the artist and the poet do not and never will see. Furthermore, the painter usually studies a limited landscape while the geologist views and tries to interpret a picture embracing worlds of space and eons of time. The scientist sees all the poet sees and more, because he understands what he is looking at.

In contrast to the old "public be damned" policy, there is a great solicitude to-day on the part of certain public utilities for the safety of the people. This has not come about rapidly nor without the force of public opinion aroused by several horrible holocausts which might have been averted to a certain extent. One of these was the so-called San Francisco fire. It is amusing to hear the rather childish contention of the real estaters and some other business men of the booster type in San Francisco that the fire, not the earthquake, did the damage. Any one at all acquainted with the facts knows that had there been no earthquake the fire probably never would have started, and secondly, it almost certainly would not have got beyond control had not the water mains been wrecked by the earth movements. The earthquake did it and the Spring Valley Water Company, whose reservoirs and mains were located along the well-known (to geologists) San Andreas fault, was rendered impotent; San Francisco, dependent upon this source of water, was, therefore, at the mercy of the flames which had been started by overturned stoves, chimneys, etc.

Later, Los Angeles built a fine new aqueduct, bringing water two hundred and fifty miles from the Sierras, and, having learned from experience, provided for just such emergencies.

Wonderful is the work of the Italian geologists in Calabria and Sicily in this branch of geology, but that is another and longer story.

Every now and then, although not as frequently as of old, some dam breaks and a town is wiped out. The Johnstown, Pennsylvania, disaster comes to the minds of those over twenty-five years

old. Nowadays, the geologist and the diamond drill are lessening the number of these dread possibilities.

The facts of deeper significance relating to the conduct of the Great War are just now coming to light and some tales of exploits not so spectacular but none the less thrilling are becoming known. One of these (which *was* spectacular) relates to the activities of geologists and mining engineers in some stupendous mining operations at Messines Ridge, where a most important strategic position occupied by the Germans was literally blown off the map through the scientific knowledge of the masters of earth science.

Another case, cited by ex-President Cross of the Geological Society of America, tells of the need of the American military officers for knowing the source of the stone used in German concrete work and how a petrographer, with his microscope, identified the particular kind of rock which was known to geologists to occur at a certain locality mapped prior to the war.

The brilliant utilization by Von Hindenburg of both his own study and that of the Russian geologists of the Mazurian Lake region is generally known. This campaign of Von Hindenburg stamped him as one of the foremost masters of scientific warfare brought to the fore by the Great War. That campaign alone has done much in my own mind to dispel the odium which the adjective German has attached to his name. He was on the wrong side, but he was none the less a brilliant strategist, perhaps the most brilliant of all the generals on any side, judging from his methods.

Up to this point we have considered only those applications of a so-called practical nature. The main theme of this discussion is, to the writer at least, far more interesting and far more important. It is that body of facts or data which can be correlated with the intellectual life and with the things of the spirit. The difficulty many people find in arriving at a rational philosophy of life is due to the fact that they have no adequate perspective; they have no true conception of time or space and our relation to each of these concepts. A great many people are rattling around in their houses like peas in a pod with nothing to which they may anchor. They are the prey of whims, superstitions and every unkind gust of the chilly winds of adversity. Not only are many of the human species drifting aimlessly, but their vague foundationless philosophies have long since faded out of the horizon, leaving many of the poor deluded earth children discouraged, others disillusioned and resentful. And so, when a poor, blundering world drifts foolishly, but helplessly, into a great international strife, we see half-crazed people try all sorts of social nostrums and political quackery. Religion itself fails to lend support perhaps for the reason that it is perverted and much of it is not real.

Once I wondered if there was any practical value in the study of paleontology aside from the use of fossils as indicators in stratigraphic studies in connection with coal and oil investigations. Since the great war, however, I have turned to the history of life, as revealed by this study and have found more real comfort and more genuine arguments against pessimism than I have gained from any other modern source. To me paleontology is one of the most practical studies in our curriculum to-day. Had Treitzke been a student of history in the largest sense of the word and not merely of that comparatively short chapter known as human history, he would have arrived at some radically different conclusions. It was he and Nietzsche with their myopic vision who misled the Prussians into thinking that they could succeed in a game that never has succeeded since the world began.

Where to-day are the Trilobites, the fighting crustaceans of the Silurian seas? Where the gigantic Ammonites of the Mesozoic? (I once saw the four-foot—diameter—shell of one of these monsters in Von Zittel's museum in Munich). The Nautilus, a comparatively small and simple cousin of this "bruiser," still lives in the warm seas. Where is the Pterodactyl? Even the present monarch of the air, the eagle, lives a lonely and vanishing life. What availeth the enormous strength of the gorilla? He hides now when puny man comes after him through the jungle. Where are the Caesars, the Alexanders and Pharaohs—where are the Huns of the sea and land and air of all history? Remember the Dinosaurs! Ruthlessness! what were you not going to do in a terror-stricken world! When the Prussian monster "superman" bellowed and spat fire, man at first did tremble, but the cry of a crucified Belgian babe aroused the world to arms to go out to meet this super-fiend and it was soon decided, this contest. The answer was, "Powder River" and a dethroned Kaiser. It is the same old kind of a fight which has been waged since the beginning of the world, only now it is moving to its culmination. The law of the jungle has been appealed to a higher court.

Ever since the onset of the Russian proletariat rebellion there have been indications of a world-wide revolt on the part of certain elements against civilization, as one writer would put it. This is not, as he thinks, a revolt against civilization, but against *our* civilization or *our order;* and half the world is panicky. Of course, this *is* a serious thing for certain classes who could not exist except for this system, but viewed in the large there is no cause for alarm as to the ultimate welfare of civilization. Geology and her sister, or shall we say daughter, science, paleontology, furnish us accounts of many such *apparently* catastrophic changes, but *always* a higher type of animal and civilization have succeeded the older.

The Bolshevik, the protestant, is the rule in geological history—without him there would be no change. The immediate change he brings about is not always pleasant or even good, but it has led and does lead to better conditions and a higher type of life. It is not the survival of the fit but of the *unfit* and discontented that has caused progress and brought about a better régime. All history, both geologic and human, proves this.

Why should I in my egotism whine because it looks as if the white man were facing a losing fight with the colored races? If the "Great Race" passes, it will be because a greater race will shove it aside. The torch of civilization (though not necessarily our own cherished kind) will continue to burn even if Fifth Avenue is overrun by the Sons of Abraham or the Golden Gate some day becomes a mere vista in a Japanese *kakemono*. Civilization will not die because *we* won't breed and must have twin-sixes instead of twins. Do not make the mistake and infer that the writer wants to see the "Great Race" superseded. He does not. As a white man, he does not like the prospect, nor does he have any immediate fear of it, but whether we like it or not, old Dame Nature is going on with the play according to her own rules and we can not stop the action by pouting and swearing about it out in the lobby.

Before this digression we were speaking of religion. It is far from my mind here to suggest something to take the place of true religion for the reason that there is nothing capable of doing this. But the fact remains that some people have not been able to recognize religion or have been driven from it by the blunders of some theologists and their champions.

Just now we are witnessing a miserable and lamentable recrudescence of the old controversy between the theologists and the scientists, this time started by William Jennings Bryan and staged in the good old state of Kentucky. Nothing will be gained by arguing these matters with people who ignore the facts, but if this sort of thing is kept up it will make that state the laughing-stock of the world and will prove a boomerang to the religious zealots and in the end will only hurt the cause of true religion. The amazing thing about this latest episode is the revelation of the amount of ignorance, misunderstanding and blind prejudice that still persists in the world. At a time when we thought we were making real progress along certain lines this comes as a shock.

There comes to mind here the name of one person, the best known and loved name in all the State of Oregon, Condon. The late Dr. Thomas Condon was formerly a missionary sent out to the Dalles when it was a mere trading post. He soon drifted out of this field into that of geology and became the first state geologist. His contributions to the geology of the state were, for his time and

training, notable, but his great contribution to the intellectual and spiritual life of the state lay in his strong advocacy of the theory of evolution at a time when most of the state was in ignorance of it and fought it. He was virtually excommunicated by the theologists, but his life and intellectual honesty have left an impress upon the state which has scarcely been equalled.

Not long since a venerable teacher and a good man came to me and frankly confessed that he got no comfort from so-called religion and he felt doubtful about the promises of the church. "What," he said, "has your science, these fossils and stones, to offer? What do they tell about the future, a world to come? Is there *any* evidence whatsoever that will give us hope?" And then I thought and thought and racked my brain and finally I said, "No, nothing that you and the world will accept as evidence. Those fossils, those granites and slates, all speak the language of the past. They tell of worlds, time worlds, that are dead. No, I can do nothing for you, can give you no comfort." And then he left me with a sad face, and I, too, was dissatisfied. And long I pondered these questions and in time there came to me bit by bit, slowly at first, but later more rapidly and clearly, a vision of things as they really were.

Aforetime they were wont to teach that this old world was hasting toward a condition of refrigeration, to a time when no more life could exist on the planet. That was a theory which could not stand the searchlight of advancing knowledge. At best it was a hopeless, pessimistic sort of doctrine and for that reason alone it had no right to last. On the other hand, cosmogonists are slowly accumulating facts which go to show that the world is improving as a place in which to live.

In the same class with this old worn-out doctrine of a cold, dead world is another doctrine of one particular school of biologists, which we believe is equally hopeless, namely, the dictum of Weismann. Here again the trouble arises from insufficiency of perspective, lack of facts. This particular school of biologists—slaves to German thought—deny the inheritance of acquired characters, citing the old stock argument about cutting off cats' tails. As can easily be seen, these are mutilations and not characters acquired through function.

If we look back through the vast stores of potent facts accumulated by paleontologists, particularly through the researches of Alpheus Hyatt and of Cope, and of the later researches of the biologist Guyer, we are faced with an increasing array of evidence in support of the theories of Aristotle and Lamarck and little to comfort the Weismannians.

But you are wanting to know, naturally, where this leads us. It leads us to a reasonable philosophy of life, one that is more in

keeping with that taught by Jesus, the Nazarene. For those who must have something more to bolster up their shaking faith we say, "Build upon the work of Chamberlin, the cosmogonist, and Lamarck, the paleontologist." The one testifies to the permanence of the habitability of man's dwelling-place, the other to the possibilities of heredity and education, of salvation through character. Let us here draw upon the felicitous expressions of Chamberlin, a major prophet of our time—to him the Lord still speaks as He did to Moses and Elijah of Old:

> The long perspective of the past should afford at least some suggestions of the future, but it must be confessed that the most important previsions are dependent on interpretations of the past that have not yet emerged from the tentative state. A word has been said relative to a possible return of a glacial epoch, but this is contingent on agencies that are yet matters of hypothesis, and no sure prediction can be offered. Question has been raised as to whether the end of the recent period of deformation has come and a gradation into another period of quiescence and equable genial conditions has begun; but the answer hangs on the doctrine of periodicity of deformation and quiescence which does not yet command universal assent, and if it were given, there would remain the further question whether the period of deformation is completed. The duration of the earth as a habitable globe has been a common theme of prognosis. A final doom of the race has been a favorite theme for quasi-scientific romances. But this all hangs on the doctrine of a former molten earth, if not also more remotely upon the doctrine of an origin from a gaseous nebula. Under the alternative conception of a slow-grown earth, conserving its energies and giving forth atmosphere as there is need for it, conjoined with a more generous conception of the energies resident in the sun and the stellar system, no narrow limit need be assigned to the habitability of the earth. A Psychozoic era, as long as the Cenozoic or the Paleozoic, or an eon as long as the cosmic and the biotic ones, may quite as well be predicted as anything else. The forecast is at best speculative, but an optimistic outlook seems to us more likely to prove true than a pessimistic one. An immeasurably higher evolution than that now reached, with attainments beyond present comprehension, is a reasonable hope.
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> The forecast of an eon of intellectual and spiritual development comparable in magnitude to the prolonged physical and biotic evolutions lends to the total view of earth-history, past and prospective, eminent moral satisfaction, and the thought that individual contributions to the higher welfare of the race may realize the fullest fruits of their permanent worth by continued influence through scarcely limited ages, gives value to life and inspiration to personal endeavor.

THE DEBT OF MEDICAL SCIENCE TO THE EARLY PRINTERS

By Dr. JAMES J. WALSH

THE art of printing, that is, of using movable type to multiply copies of manuscripts, was, as is well known, taken up enthusiastically all over Europe immediately after its invention. It is a surpassing tribute to the progressive enterprising qualities of the men of the middle of the fifteenth century, when the Middle Ages, usually thought so unprogressive, were drawing to a close, to note in how short a time the new art was brought to perfection and came to be recognized in all the civilized countries. In the course of a few decades, indeed within scarcely more than a single generation, there were printing presses and printers' establishments turning out volumes in all the modern languages as well as in Latin and Greek, many of which have been precious monuments ever since. We are rather proud of the fact that the telephone "caught on" with such rapidity in our time, but the use of printing spread quite as rapidly in the mid-fifteenth century. The telephone is a convenience for business, while printing has always been, until abuses came in our time, the handmaid of literature and science.

The history of printing for the forty years before the discovery of America shows very clearly that men were not lacking in initiative in the long ago whenever a worthwhile stimulus came to arouse them. What is most interesting, however, for us here is the supreme scholarliness with which the new art was applied. We are in the midst of a flood of utterly trivial and often absolutely useless material that pours from the press at the present time in the form of books and periodicals. By contrast it is a never-ending source of surprise to see how these earliest printers devoted themselves to the perpetuation and publication of the best things that had been circulating in manuscript. Above all, the value of the recently invented mode of easy book-making as a means of rendering the precious works of the older times available for ever so many more readers than before was recognized and taken advantage of with a promptness and a thoroughness which demonstrate quite conclusively that the early printers, as a rule, looked upon their vocation as a profession rather than a trade. No amount of trouble seemed too much for these men to take in order to send forth worthy products from their presses. In all the countries the most important members of the new craft felt that they were working for the

benefit of mankind, not only in their own generation but for the generations to come, rather than in any sense of the word merely giving themselves and their time and labor to an occupation by which a living was to be made, much less any large amount of money to be accumulated. A great many of these early printers were scholars deeply intent on the education of their generation and the affording of every possible provision for the ready contact of the men of their time with the most valuable products of the human intellect that had been written in preceding generations.

Almost needless to say, compared to printing in our time the making of printed books in that first generation after the invention of movable type was an extremely slow, laborious process. It is true that the new mode of book-making was almost infinitely superior to long hand-writing in the multiplication of copies of books, yet it was so far below what we have come to make of printing in facility that it is very dubious if the most persistent of the men of our time would have the patience and the diligent industry necessary for any such issuance of printed books as poured from the presses of the earlier Renaissance period. Fortunately, the first printers had before them as examples of book-making the very beautiful manuscript volumes of the immediately preceding period, when some of the most charming books ever made had been produced entirely by hand. Now that we in our time have come once more to know these marvelous manuscript copies very well and are perforce compelled to deep admiration of them, we can understand better the expression of a great Italian bibliophile of that first generation of printing, who, having a magnificent collection of manuscript works refused to buy any of these "machine-made books," as he contemptuously called what must have seemed to him the cheap, new-fangled volumes which were just coming into vogue.

There was one very decided advantage in the difficulties of early printing and the time-taking pains demanded by printed book-making in the pioneer days. No one felt like devoting the time and trouble and energy required for getting out a book, to say nothing for the moment of the expense, to any work that was not worth all that had to be put into it. Later, it became so easy to print books, indeed it was, until the recent war came to raise the price of print paper, such a comparatively cheap and almost entirely mechanical series of processes to print and bind them that all sorts of trivial trash was accorded the dignity of appearance in book form and granted the full freedom of bookdom. The result is that we are fairly overwhelmed with printed volumes, most of them destined to be almost literally ephemeral, the creatures of a day. It has accordingly become a matter of no little difficulty for readers to avoid wasting time over some of the worthless books and

almost more difficult to be able to choose with assurance those that are worthy of time and attention. No wonder that there has been serious discussion of the question whether the printing press really conferred a benefit on mankind or not.

There is only one compensation in our mechanical book-making, and that is the fact that there is a minimum waste of time and energy on the many valueless subjects of it, and most of them are destined to a very brief existence. When book-making was cheapest at the end of the nineteenth and beginning of the twentieth century and above all when for a time we were experimenting with wood-pulp paper with the idea that it might replace better stock in book-making, we made a large number of very perishable books, the leaves of which fairly crumble in the hands now and that are evidently going to fall to pieces before long. A devout follower of William Morris once declared in connection with this, "Thank God that most of these cheap books which were born yesterday will be dead to-morrow, and thank God for the wood pulp paper they are printed on, for they will crumble to pieces in a few years and we shall not have to give them space on our library shelves."

Almost needless to say, the Renaissance printers thought entirely too much of books for their own sakes to treat them in any such fashion as this. They used the very best paper stock, fine carbon ink, substantial binding, and their books, if anything of this kind may be expected to last, would seem destined to immortality if only accorded a modicum of care. That is the reason why now in the midst of the growing interest in incunabula of all kinds so many men, even though not of the millionaire class, can enjoy the privilege of having some of them in their libraries.

The Renaissance printers in choosing books that would be worthy of time and labor they had to devote to them displayed eminently critical good judgment. In spite of the difficulties presented, practically all the great classics were in type before 1500, and though scholars had to be procured, sometimes even from a distance, to edit them and the collation of manuscripts at times distant from each other had to be made, nothing daunted, the printers proceeded to get out these *Editiones principes,* those princely first editions which have meant so much as a rule ever since.

So far as the classics were concerned, it was almost as easy to choose the authors that should have the honor of early printing, as it is in the modern time to make a five foot shelf of books really worth while. When it came to choosing the volumes that should be printed apart from the classics, a heavy burden of responsibility in the choice was placed upon the early printers' shoulders, and it is marvelous to look back now and see how well they bore up under

it and succeeded so well in solving the problems which it involved. In nearly every department of thought they succeeded in picking out those contributions to human thinking that were best worth while preserving for future generations and making as readily available as possible for their own a reasonably large collection of incunabula in a marvelously representative compendium of most of the best thought of humanity down to the Renaissance time.

In medicine this is particularly true and the early printers, especially in Italy, presented the world with a collection of medical and surgical books unsurpassed in interest, enshrining some of the greatest thinking that had been done down to the Renaissance time. Most of these existed in a number of manuscripts so that it was comparatively easy at that time to print them in authoritative and authentic editions. Had there been any delay in the printing of them the neglect of manuscript materials which began in the second half of the sixteenth century would almost surely have brought about a disappearance of many important books, the printing of which preserved them very effectively. We have only come to realize in recent years how many volumes, important not only for the history of medicine but as illustrating how our professional colleagues of centuries ago anticipated some of our best thoughts, might have been lost only for the zeal and the scholarship and the excellent critical judgment of these early Renaissance printers. Medicine owes them an immense debt which we can repay only by worthy admiration of their work in these succeeding centuries.

Another very valuable feature of their work was that the printing was done in such magnificent editions that their great books were considered valuable for themselves quite apart from the interest of the medical or surgical material which they contained, and accordingly they were preserved as precious treasures of the printing art, when the ebb tide of interest in later medieval medicine and surgery set in. For there came a time not long after the invention of printing when the people of the later Renaissance began to talk of everything before the Renaissance as "the Dark Ages" and when the word Gothic was invented and applied to things medieval with the implication that all that was done before Greek and classic Latin were introduced into the modern world was quite unworthy of the classic period and to be considered as representative only of the barbaric ancestors called by the single contemptuous term the Goths. These older writings in any less valuable material form might very well have disappeared. Gothic applied to literature, to some extent at least, as well as to architecture. The poetry, the philosophy and the art of the medievalists were supposed to be no more worthy of admiration but on the con-

trary to be scoffed at quite as much as the architecture. No wonder there was danger of medieval literary works disappearing. With the return of admiration for Gothic architecture the other medieval modes of thought have come into their own of admiration and proper appreciation once more. In the meantime their value as magnificent examples of the printers' art had saved many of them from neglect and probably from destruction. This was particularly true of the early printed editions of the medical books of the Middle Ages in the strict sense of that term and also of the popular medical books and especially books of reference containing articles on medical subjects. For several centuries the contents of these books was supposed not to give them a value that would make them worth while preserving, but their quality as achievements of the early printers gave them a special significance and made them precious.

Our own great surgeon general's library, beyond all doubt the best medical library in the world, possesses a whole series of these books, probably the completest collection of its kind in the world. A surprise to any one unaccustomed to seeing copies of these early printed books is the magnificent character of the volumes. They are beautifully printed on fine paper, substantially bound, and in spite of the vicissitudes of time for what is now nearly five hundred years, they are in excellent condition. After all, when anything made by men is still in good shape for use after half a millennium it may be considered a permanent enrichment of the precious heritages of the race. When it is constructed of such materials as paper and leather, usually thought of as rather perishable, and yet carries its message after a dozen of generations, there is no doubt at all that the men who made it secured a triumph in the mingling of the useful and the beautiful. Horace said, Qui miscuit utila dulci omne tulit punctum—"he who mingles the useful with the beautiful carries off every point." Surely the great Latin poet's expression applies nowhere with more propriety than to this question of the place of distinction deserved by the printers of the medical books of the fifteenth century.

Medical Incunabula

An excellent idea of the critical judgment of these early printers in selecting medical works for reproduction will be derived from the fact that the well-known "Regimen Sanitatis Salernitanum" went through no less than twenty editions before the end of the fifteenth century. We have come to realize how precious were the hygienic precepts laid down in this little volume, collected, some of them at least, very probably by the professors of the medical school of Salerno as early as the twelfth century. Twenty editions

seems a very large number for a book in the very first generation of printing, but as it is probable that more than 300 editions of the "Regimen" have been printed since, it would seem as though these early printers had established an average which succeeding generations were to try to maintain as they came to appreciate the little book properly. This story of the manual of health of Salerno is of itself a striking testimony to the value of incunabula. A book that was as popular as this must not only have been widely read, but must have produced deep effects. There are few more sensible collections of rules for health than are to be found in this little volume, so that its influence for good must have been immense, and it furnishes a new point of view for the history of medicine.

The labor and expense to which they were willing to go in what they considered the worthy printing of medical books is very well illustrated by the Ketham (John of Ketham) 1493 edition of Mondinus or Mondino, the well-known anatomical teacher and writer of the fourteenth century. There is a picture of a lesson in dissection reproduced in this volume in four colors by means of stencils. The faces of the attendants are so vivid and lifelike that it seems clear that they must have been taken from the life. Subsequent editions are distinctly inferior. This first edition made at the height of the Renaissance is worthy in every way of the time in which it was made, and there are other illustrations and one famous feminine anatomical figure drawn from the subject, the first of its kind, which shows that the printer went for his illustrations to some one of the distinguished artists of the time and not to some hack worker who had recognized the opportunity for money-making in connection with art work for the printer and given himself to that new profession. Even when there are editions of these volumes later than 1500, printing and illustrations are still under the influence of the early spirit and represent better work than in most of the subsequent times.

What a precious incentive for the men of the Renaissance time, intent on making scientific as well as artistic and literary advances, to have before them the works of the men who represented the experience of the earlier middle ages, for instance, when the full tradition of Hippocrates and Galen still lived on and was applied by men who weighed discriminatingly and tested clinically the hints as to diagnosis and treatment received from the old-time Greeks. It would have been too bad, indeed, if the works of such men as Aëtius, Alexander of Tralles and Paul of Aegina had not been available for the consultation of Renaissance scholars. All these knew their Greek classic medicine and were themselves making important observations. Their works were thoroughly appreciated, as is easy to

understand from the expression of Cornelius (16th century) with regard to Aëtius, for he declared that the easiest way to get a summary of all that the old physicians had recommended and the old surgeons attempted was to "find it in Aëtius." It was particularly valuable to have these writers made available just when the growing knowledge of Latin and Greek made consultation of them possible by a great many physicians, for teachers, at least of medicine, in the Renaissance days were almost as a rule very scholarly individuals thoroughly up to date in their educational interests.

It was doubtless because of the existence of this important clientèle that the editions of the early medieval Greek medical authors were made. Paul of Aëgina and Alexander of Tralles are full of practical hints that must have been eminently suggestive in the medical and surgical practice of the enterprising members of the medical profession in the Renaissance period. Alexander, for instance, has a very interesting and thoroughly modern treatment of consumption. His prescription for consumptives was "an abundance of milk with a hearty nutritious diet as digestible as possible." Besides this, he recommended change of air, suggesting a stay at a watering place or a sea voyage.

We have come back to a great extent to Alexander's way of looking at epilepsy. He recommended a plain simple diet with regular bowels and special attention to the gastro-intestinal tract. Baths were recommended and regular exercise and sexual abstinence. He rejected treatment of the condition by surgery of the head either by trephining or by incisions or by cauterization. He insisted above all that the physician should not depend on any single method of treatment for disease, but "should be an inventor and think out new ways and means by which the cure of the patient's affection and the relief of his symptoms may be brought about."

One of the most important of what may be called the extraneous factors in the development of medicine which have been preserved for us by the early printers is Nicholas of Cusa, an edition of whose works in two volumes probably was printed before 1476. He was a Roman cardinal very much interested in science, who declared that "the earth is a star like other stars, is not the center of the universe, is not at rest nor are its poles fixed." These declarations were made before 1450. He was particularly interested in certain medical problems, and in his dialogue "On statie experiments," which he wrote in 1450, suggested obtaining the comparative weights of the blood and urine at various ages and in various diseases, for the weight with the color would tell him more than the color alone. He also suggested that the pulse should be counted

a hundred times in various patients under varying conditions of health and then the weights of water which ran through a clepsydra or water clock, for other clocks were not readily available, should be compared. He has been hailed, as a consequence of this and similar suggestions with regard to the counting of the respiration and with regard to the therapeutic value of various pharmacal materials by means of their specific gravities as well as other physical qualities, as the pioneer for the use of definite scientific or laboratory methods to secure greater accuracy in diagnosis and dosage.

Surgical Incunabula

Surgery is even better represented among the cradle books than medicine. One of the volumes that well deserves a mention among the incunabula is the edition of Guy de Chaulaic, issued at Venice in 1480. He was the first of the great medieval surgeons thus to be given the dignity of print some fifteen years before the others were accorded the privilege, but surely no one would deny him the right to this distinction. Few men have ever written more valuable material with regard to surgery for their own time and for many succeeding generations than this great Papal physician who, after having studied in Italy, taught at Montpellier and then sat down, knowing the writings on surgery that had been made before his time, to give his generation a real textbook. The man who said that a man who practiced surgery without knowing anatomy was like a blind carpenter sawing wood was emphasizing fundamentals in the right way. He dwelt on the fact that the great hamperer of progress in medicine was thoughtless following of others without studying the subject for one's self and finding out just as far as possible just exactly what conditions were. No wonder that he has been held in high honor by the French ever since, and that all the world has come to agree with them in their reverence during the last few generations.

What a loss it would have been to the history of surgery if that notable incunabulum, the *Cyrurgia,* printed by Andrea Torresani de Asule at Venice in 1499, had failed for some reason to be printed. It contains the textbooks on surgery of Bruno of Longoburgo, of Theodoric, of Roland and of Roger of Bertapaglia, the great Italian surgeons of the thirteenth century, as well as of Lanfranc and of Guy de Chaulaic, the French surgeons who came a little later.

Only that we have this or some similar printed record it would have been quite impossible for our generation to believe that surgeons seven centuries ago had anticipated so many ideas in surgery that we are inclined to think of as representing modern dis-

coveries and inventions. The practice of surgery sank to such a low ebb in the first half of the nineteenth century that no one would have believed that what these professors of surgery at medieval universities relate as their experiences were anything more than fairy tales if anybody had tried to retell them a century ago or so. Had they been kept only in manuscript form, almost surely all knowledge of them would have disappeared because of not only the utter lack of interest but even the contempt in which they would have been held had their contents been noted at any time for nearly two centuries in the modern period. As it is, they were saved for us by the printers of the Renaissance and now are available to teach us the precious lesson that whenever men set their minds and hearts to solving human problems they solve them very well in spite of the difficulties there may be in the way. What is needed is the will to solve them.

These old surgeons operated extensively, daring to invade even the three great cavities of the body, the skull, the abdomen and the thorax, the last, at least in a limited way. Their operations upon the skull for the raising of depressed bone were very thorough and yet conducted with a delicacy of technique that saved the patient from further harm, and they recognized such conditions as linear fractures and the possibility of fracture by *contrecoup*. Their opening of the skull is not surprising, for of course a great many of the savage nations of the world have done trephining for one reason or another, but what stamps the work of the medieval surgeons in this regard is the completeness of the technique which they suggest. Their operations within the abdomen, especially for wounds in the intestines, which must have been rather common in the hand-to-hand conflict and sword play of the time, form another matter for surprise to those who think of these abdominal operations as developing only in our day. Some of these surgeons describe the use of metal tubes to keep the intestines patulous while the healing process was going on, and the Brancas, father and son, in surgery, developed the use of the trachea of animals for their intestinal anastomosis, because this would not have to be passed out of the body, but would be gradually dissolved in the secretions, though not until ample time had been allowed for healing. They used strong wine as the only dressing and got union by first intention and boasted of it. Their treatment of compound fractures is extremely interesting, because any one who will refer to the textbooks on surgery of scarcely more than a generation ago will find what an opprobrium to modern surgery the treatment of compound fractures was and how many men preferred to amputate rather than take the risk of pyemia which was so often involved.

They insisted particularly that proper nutrition was an extremely important element for the healing of small as well as great wounds and that therefore the surgeon must know what is likely to be of assistance to his patients in these regards. Theodoric declared that:

> The physician must, above all, not be ignorant of the kind of food materials that generate good chyme and good blood. Out of such materials the wounded man must be fed, in order that a suitable diet shall bring about a restoration of health and the renascence of the flesh and the restoration of the continuity of the wound.

I have told in an article in the *Annals of the History of Medicine*, Vol. II, No. 1, the story of what these surgeons did for the development of laryngology and rhinology seven centuries ago. It was not until the end of the nineteenth century here in America—indeed most of the original work was done here in New York City—that these two specialties developed once more. How far their development had gone in the older time is well preserved for us in this Venetian *incunabulum* which enshrines so much of the medieval surgical experience. There are descriptions of how to remove the tonsils and the uvula if that is deemed necessary, and how to treat even retro-esophageal abscess and edema of the glottis. Bruno, usually called of Longoburgo because of his birthplace, who taught at Verona and Padua and who finished his textbook of surgery, the "Chirurgia Magna," at Padua in January, 1252, describes several varieties of nasal polyps, and above all differentiates one of them as a malignant tumor. His description of it shows his clinical powers of observation, for he says that it was of darker color, of slight sensibility and very hard. His conservatism was demonstrated by his advice that it should not be operated upon, for operation only hastened the growth and led all the sooner to the death of the patient. Bruno insisted that obstructions of the nose should be removed and suggested a number of technical details to facilitate this, including cauterization.

The one thing that the modern generations can well be extremely sorry for is that the early printers never got a chance to print Marcantonio's "Anatomy," illustrated by Leonardo da Vinci's plates. There is, I believe, a letter of Leonardo da Vinci extant in which he says that he was working at a book on anatomy. We had no idea at all until the present generation how much work he did at it. Altogether, many hundreds of plates of dissection have been found made by Leonardo da Vinci, and they represent the best things of their kind that were done down to Vesalius's day, nearly a full half century later. Indeed, in certain ways Leonardo's pictured dissections are ahead of those of Vesalius, and they possess

the added merit of the great artist's wonderful power of visualization. Had the early printers secured an opportunity to print this we would have had probably the most precious incunabulum in the world. As it is, Leonardo's plates were left to be printed for the first time full four centuries after he made them, though he actually finished them within practically a generation after the middle ages and had done some of them before the middle ages closed, if one were to take as the date of that the discovery of America, as some historians seem inclined to do, in recent years.

Some of the medical and surgical incunabula are among the most beautiful printed books ever published. The examples in the library of the New York Academy of Medicine illustrate that. What a curious contradiction of the ordinary impression about progress in mankind and its supposed constancy and above all its tending to a climax in our time is to be found in the history of printing. Some of the most beautiful printed books ever issued were printed in the first generation of the history of printing. Indeed, I think it may well be said that some of them were printed in the first ten years after the German method of the use of movable type became an open secret. Toward the end of the nineteenth century, on the other hand, we were doing some of the vilest printing that has ever been done in the history of the art. Vile means cheap, to be sold for a low price and that is what most of our books literally were made for. When William Morris, disgusted with the cheap paper, the indistinct type faces, the bad spacing and the poor impressions, set about the reform of printing and proceeded to make some beautiful editions, he went straight back to some of the very earliest printed books and imitating them in every particular, from the hand-made paper and the type faces to the spacing and the margins, revived the cult of beautiful pages once more and brought us back to the printing of a time that is now coming to be nearly 500 years ago.

Popular Medical Information

An extremely valuable feature of the work of the early printers for medicine consisted in the printing of the old encyclopedias or popular sources of information which had been circulating in manuscript sometimes for centuries, representing better than anything else the interests of educated people and at the same time served to show what was the knowledge which the majority of them possessed from which to draw their practical conclusions on a great many subjects. It is easy to understand that medicine and subjects related to it would occupy no inconsiderable place in these old-time encyclopedias. It has been rather the custom to think that most of

what was contained in popular information with regard to medicine in the older time was absurd. Indeed, it has been a favorite commonplace of writers with regard to popular medicine in the middle ages and especially those who made short references to it out of a comparatively small amount of information to emphasize the utter absurdity of popular medicine notions, particularly six or seven centuries ago.

Undoubtedly, there were a great many absurdities in medieval medicine, but then it is beyond all doubt that there have been absurdities in medicine at all times. We have had an abundance of them in our time. Even our generation has been caught two or three times by the idea that testicular tissue from animals might very well serve to renew man's vitality, and we have wanted so much to have some such fountain of youth that we have been tempted beyond our strength to take up some of the most absurd ideas. There are good honest physicians and surgeons who insist that, while there may be and probably is some valuable idea underlying the theory of the vaccines, there is no doubt at all that the use of these has been carried to absurd lengths, and then of course we have had all sorts of drugs that have come and gone, most of them absolutely inert, fortunately, but not a few of them harmful to some degree at least and yet used for a time by physicians, and not infrequently adopted and advertised by the irregulars on the strength of professional commendations until large amounts of money were expended for them. The glass in our modern therapeutic houses is entirely too thin for us to afford to throw any stones at the absurdities of medieval therapeutics.

What is surprising, however, in the books of popular information provided for the medieval period is the amount of valuable details of ascertained knowledge which these old encyclopedists presented and which formed the mental pabulum for information seekers some seven centuries ago. This is true for a number of these old tomes.

Probably the most famous of them is the "Speculum," that is, The Mirror, in the sense of something that you look into in order to find what you want, of Vincent of Beauvais. Ordinarily, it would be assumed that encyclopedias in the middle ages must have been very brief in size compared to ours, partly because there was not enough information known to make large volumes and, secondly, because interest in them was not sufficient to encourage the making of them. Vincent had, however, that scholarly monarch, Louis IX, who did so much for the University of Paris and especially the Sorbonne, for patron, and that fact supplied the necessary stimulus as well as the means, and so the great Dominican encyclo-

pedist was able to employ a number of his fellow Dominicans as assistants and they made a magnificent encyclopedia. It has been calculated that the "Speculum Majus" contains as much material as would be comprised in some fifty octavo volumes in the modern time. No wonder that it was called "Bibliotheca Mundi," "Library of the World," in the old time. The book was such a favorite that, in spite of the immense labor involved in copying such a huge work, there is scarcely an important library in Europe which does not contain one or more manuscript copies of it and it was evidently available to all who wanted to consult it in every important center of intellectual interest in Europe.

The date of the *editio princeps* is not absolutely known, since, like all the other early printed books, it is issued without date, but it is calculated to be some time between 1463 and 1470. The original edition is magnificently printed with fine, clear type faces, good spacing, easy to read, apart from the abbreviations which occur in the text, beautifully rubricated, the whole on precious hand-made paper, with wide margins, the pages remaining without discoloration from any disintegration of the paper even to the present day. It could only have been a labor of love that would dictate this magnificent form for so huge a work, considering the labor and expense which the early printers had to give to it, and yet it must have been issued in a good large edition, for there are a great many copies of this earliest issue still preserved, and I suppose there must be a dozen or perhaps a score of them here in America.

The French Universal Dictionary calls attention to some of the details of information in Vincent which are usually supposed to be much later in origin. For instance, the rotundity of the earth and the existence of antipodes are both treated as established facts. It is suggested that if a stone were to be dropped through a hole made through the earth's sphere it would come to rest at the center of the earth. He points out that superheated steam digests animal tissues, anticipating something of Papin's work, and he was familiar with many details of physiology usually supposed to have come much later.

Another of these old encyclopedists, whose work was issued in a series of magnificent editions as *incunabula*, is Bartholomaeus Anglicus, known as Bartholomew, the Englishman, or Bartholomew of Glanville, who wrote a work called in the original Latin *De proprietatibus rerum*, "On the Properties of Things." This was probably completed some time about the middle of the thirteenth century. It was written to provide information for priests in the fulfillment of their various ecclesiastical duties as preachers, advisers, confessors and, as a modern writer has suggested, would

probably be called in the modern time "The Clerical Repertory for the Interpretation of Holy Scripture." Almost needless to say, this would require no little attention to the diseases of mankind, and as a matter of fact the seventh book is taken up with the question of the ailments of men, *De infirmitatibus.*

This came to be one of the most popular books in Europe, consulted by practically all the intellectual folk when information was desired. The University of Paris kept two copies for public use, the one for the consultation of "poor teachers of the Sorbonne" (teachers' salaries have always kept them poor) which apparently might be borrowed for a time and taken to the teacher's room, while the other, intended for the students, was chained to a desk in the college chapel, representing one of those chained books of which so much was said when it was thought that the Bible was the only chained book. It is extant in numberless manuscript copies, and there have been many editions of it in print. Father Plassmann of St. Bonaventure's College, Allegheny, N. Y., who reviewed the whole subject of the authorship of the book and found the clue through the unfortunate confusion of the true name and date for the author, calls attention to the many translations of the book into the vernacular languages of Europe. There were versions in French, one of them famous as a literary monument of the French language, into Flemish, Spanish and English as well as the Provençal. The translation into English was printed by Wynkyn de Worde and is said to be the *chef-d'oeuvre* of this press. There is a tradition that Shakespeare was familiar with this volume, and that not a few of his curiosities of information with regard to natural history are due to consultation of it.

Very probably the most interesting paragraph for physicians in Bartholomew is his summary for priests of what he thought proper for them to know with regard to the insane. His paragraph is, I think, one of the most striking brief compendiums of what should be known about the insane that has ever been written. I doubt if any one in the modern time could write a better summing up of knowledge, real knowledge due to observation as to the insane, than Bartholomew has given. I quote the paragraph in the quaint translation given in "Medieval Lore" (London 1893), which is taken from a very old English version, sometimes thought to be the one that Shakespeare consulted:

> Madness cometh sometime of passions of the soul, as of business and of great thoughts, of sorrow and of too great study, and of dread: sometime of the biting of a wood (mad) hound, or some other venomous beast; sometime of melancholy meats, and sometime of drink of strong wine. And as the causes be diverse, the tokens and signs be diverse. For some cry and leap and hurt

and wound themselves and other men, and darken and hide themselves in privy and secret places. The medicine of them is, that they be bound, that they hurt not themselves and other men. And namely, such shall be refreshed, and comforted, and withdrawn from cause and matter of dread and busy thoughts. And they must be gladdened with instruments of music, and some deal be occupied.

These are only a few items in the long accounts of what medicine owes to the early printers. Perhaps our appreciation can be measured by the prices which medical incunabula, to say nothing of other "cradle books," command at the present time. If that is a measure, then we are not inappreciative, but on the contrary our recognition of the work of these men can be measured highly in that most important standard of values of our day, the money of the realm. Try to buy some of the incunabula and see what you are asked for them and you will understand present-day appreciation better than I could tell you.

OCCUPATIONS IN THE UNITED STATES

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THE record of the changes in occupation in the United States as reported in two censuses, 1910 and 1920, may be of temporary interest as a measurement of the economic changes during the interval between the two periods, or it may have a more permanent value if the shifting of labor from one group of industries to another shows over a number of years a persistent trend. Whatever their value, the rearrangement of some of the tables of the fourteenth census of the United States, particularly in this instance of those of the abstract of occupation statistics, brings into prominence some changes which have been known or long suspected and others that are little realized.

THE GROUP SUBJECT TO OCCUPATION

Table I, which gives statistics from 1880 to 1920 inclusive, shows that the percentage of population over 10 years of age has increased from 73 per cent. in 1880 to 78 per cent. in 1910, and no further increase is recorded in 1920. If there is any proper ratio which

TABLE I

Year	Total population	Population over 10 years	Per cent. of Total	Per cent. of population over 10 years old gainfully occupied
1880	50,155,783	36,761,607	73	47.3
1890	62,622,250	47,413,559	75	49.2
1900	75,994,575	57,949,824	76	50.2
1910	91,972,266	71,580,270	78	53.3
1920	105,710,626	82,739,315	78	50.3

ought to be maintained between the group over 10 years old and the total population, in order that the race may properly perpetuate itself, the writer does not know it. Certainly, the percentage of persons over 10 years old can not go on increasing indefinitely. Two or three queries arise from the table. Is the increase in percentage of population over 10 years old to the total population due to an influx of adult foreigners? Is the lack of increase in the percentage over 10 years old in 1920 the result of the restriction of immigration? Does the increasing percentage of the population over 10 years old mean a gradually lessening birth rate? Or does

the lack of increase in this population in 1920 reflect the losses in war due to casualties and the return of the foreign born to add to the man power of the armies of their native land?

It would appear that the influx of adult population aided the increases of the population over 10 years of age and also was a factor in the lack of increase in the percentage between 1910 and 1920, but it can not account for the full amount of these increases. Table II shows the immigration for ten-year periods from 1880 to 1920, with the number of children below 14 years of age during the last two decades.

TABLE II

Immigration in 10 years per 1000 initial population	Decade	Total immigration during the 10 year period	Number of children under 14 years
104	1881–1890	5,246,613	
61	1891–1900	3,844,420	
116	1901–1910	8,795,386	1,058,541
62	1911–1920	5,735,811	814,377

In the two periods, 1901–1910 and 1911–1920, the percentage of children to the total immigration was about 12; these referred to children under 14 years and in the latter period for a few years it included the children under 16 years. If figures were given for children under 10 years the percentage would have been much smaller. In Table I, the percentage of children under 10 years ranges from 22 per cent. to 27 per cent., which, taken in comparison with the percentages of immigration above, shows a marked percentage in favor of adult immigration.

In Table III, which gives the proportion of males to the total immigration, it will be seen that the proportion has constantly increased with the exception of the year 1914 which registered a slight decrease, possibly as a wartime factor. In general the older migrations to this country appear to be by families, and the newer less so. Even in the later years, certain races, the Hebrews, Germans and English, have migrated by families rather than by adult males; but these are largely offset by the newer group of immigrants who have apparently been represented by the men of the families.

TABLE III

Years	Percentage of males to total immigration
1893–1895	61.5
1896–1900	63.5
1904–1905	69.2
1914	65.4

On the other hand, the lack of increase for 1920 (Table I) in

the percentage over 10 years old can not be ascribed in any large degree to the restriction of immigration; and in a less degree can the cause be found in the return of native sons to the aid of the land of their birth. Table II shows that while the immigration for the decade, 1911 to 1920, was less than that of the decade, 1901 to 1910, it was greater than during any previous decade. Table IV

TABLE IV

Years	Aliens departed
1908	395,073
1909	225,802
1910	202,436
1914	303,338
1915	204,074
1919	123,522
1920	288,315
1921	247,718
1922	198,712

gives the number of departures for selected years between 1908 and 1922 covering the wartime period. This table leads Mr. J. C. Welliver[1] to remark that the report of a great return of aliens to Europe to take part in the war was very much of a fiction. Mr. Welliver also calls attention to the sum of the departures during 1915 and 1916, which was 333,839; while the average yearly departure during the four years previous was 310,000.

One other factor must be admitted to explain the constantly increasing population over 10 years old. Table V lists the number of families and the size of the family from 1850 to 1920.

TABLE V

Census year	Number of families	Persons to a family
1850	3,598,240	5.6
1860	5,210,934	5.3
1870	7,579,363	5.1
1880	9,945,916	5.0
1890	12,690,152	4.9
1900	16,187,715	4.7
1910	20,255,555	4.5
1920	24,351,676	4.3

The family in this instance is the "economic family," not the natural family, and it may vary from a person living alone to the entire population of an institution. The summary of the census on dwellings and families states that "it is believed, however, that the changes in the average size of census families from decade to decade, as well as the variations in this respect among the geographic divisions and states, are due mainly to differences in the size of private families and particularly in the number of children."

[1] Judson C. Welliver, "World migrations and American immigration," *Amer. Rev. of Rev.*, LXVIII, No. 403, Aug., 1923, 193–200.

One is safe, then, in the conclusion that the main factors in the increasing percentage of the population over 10 years old are adult immigration and the decreasing birth rate.

Gains and Losses in Occupations, 1910–1920

Table VI shows the numbers engaged in the various occupations in 1920 and the percentage of the gains (+) and losses (—) recorded over the 1910 figures. The classification is the one adopted by the 1920 census, which is "occupational rather than industrial."

TABLE VI

Occupation	Per cent. loss or gain	1920 totals
All occupations	+ 9	41,614,248
1. Agriculture, forestry and animal husbandry	— 14	10,953,158
2. Extraction of minerals	+ 13	1,090,223
3. Manufacturing and mechanical industries	+ 21	12,818,524
4. Transportation	+ 15	3,063,582
5. Trade	+ 16	4,242,979
6. Public service (not otherwise classified)	+ 70	770,460
7. Professional service	+ 30	2,143,889
8. Domestic and personal service	— 10	3,404,892
9. Clerical occupations	+ 79	3,126,541

It will be noted that in the large groups of this table losses were sustained in the agricultural group and the domestic service group. Both of these losses have been generally recognized; the former by constant references to the diminution in farm labor by newspaper and magazine articles, and the latter by the inability of housekeepers to obtain domestic help with the ease prevalent in 1910. On the other hand there are very large increases in the clerical occupations group and the public service group, with normal increases in the remaining groups. In order to better analyze the situation abbreviated tables are presented showing the distribution in detail of the sub-occupations under the larger classifications of Table VI.

Agriculture, Forestry and Animal Husbandry

Table VII indicates a great increase in foremen and a great decrease in laborers. Second to these are the increases in lumbermen, raftsmen and wood-choppers and the decrease in fishermen and oystermen. In these four cases there seems to be justification for the explanatory note of the Census Bureau stating that the loss in agriculture may be due to the change of time in taking the census. The 1910 census was of April 15, and the 1920 of January 1, and since farm labor is a seasonal occupation and January the dull season, a loss may be expected, inasmuch as a large number of farm laborers may have been missed or assigned to other occupa-

TABLE VII

Subheadings of agriculture, forestry and animal husbandry group	Gains or losses per cent.	Totals so occupied 1920
Dairy farm, farm, garden and orchard foremen	+82	93,048
Lumbermen, raftsmen, wood choppers	+27	205,315
Gardeners, florists, fruit growers, nurserymen	+22	169,399
Owners and managers of log and timber camps	+ 6	8,410
Dairy farmers, farmers, stock raisers	+ 4	6,201,261
Garden, greenhouse, orchard and nursery laborers	+ 3	137,010
Other agriculturist and animal husbandry pursuits (apiarists, poultry raisers, bailers, etc.)	— 8	401,599
Fishermen and oystermen	—24	52,836
Dairy farm, farm and stock farm laborers	—37	4,041,627

tions by the enumerators in 1920. That there is some justification in this attitude is upheld by the tables in the gains established by other seasonal occupations, particularly in lumbering and wood-chopping; and also by the losses in the number of fishermen and oystermen. Just how effective this change of time was in affecting the numbers in the occupation mentioned may be judged from the following table (Table VIII).

TABLE VIII

	Numbers in			
Occupation	1890	1900	1910	1920
Agricultural pursuits	8,565,929	10,438,219	12,659,082	10,953,158
Agricultural laborers	4,410,877	4,459,346	6,069,321	4,041,627
Fishermen, oystermen	60,162	73,190	68,275	52,836
Lumbermen, wood-choppers	65,866	72,190	161,268	205,315

The change in the census period has been made twice recently; in 1900 the enumeration is of July 1. The change from July to April did not apparently cause a diminution in the agricultural laborers, even though July is the busy time for agricultural work. On the other hand, the increases and decreases in the other two industries appear to be radically affected by the seasonal factor.

Extraction of Minerals

This group, which registered an increase as a whole of 13 per cent., has individual occupations ranging from an increase of 213 per cent. to a decrease of 9 per cent., as shown by Table IX.

TABLE IX

Subheadings of extraction of minerals group	Loss or gain percentage.	1920 totals
Oil, gas and salt well operatives	+213	91,022
Foremen, overseers and inspectors	+ 54	36,931
Operators, officials and managers	+ 36	34,325
Coal mine operatives	+ 19	733,936
Quarry operatives	— 4	45,162
Operatives in other mines (lead, zinc, etc.)	— 9	41,162

The great increase in the production of oil in recent years would

make the increase of 213 per cent. in oil and gas well operatives easy of acceptance. Possibly, as in the case of the other industries of Table VII, the decreases in the last two items under mining operations may be due to the seasonal feature of the industry.

Manufacturing and Mechanical Pursuits

TABLE X

Subheadings of manufacturing and mechanical pursuits group	Loss or gain per cent.	1920 totals
Cotton mills—semi-skilled operatives	+ 102	302,454
Iron and steel industries (semi-skilled operatives)	+ 87	689,980
Machinists, mill wrights, tool-makers	+ 83	894,622
Iron and steel industries—laborers	+ 51	729,613
Carpenters	+ 8	887,379
Clothing industry (semi-skilled operatives)	+ 6	409,361
Lumber and furniture industries—laborers	+ 1	320,613
Painters, glaziers, varnishers, etc.	— 2	323,032
General building laborers	— 28	623,203

This table has been abbreviated to include only those occupations in which the total numbers engaged exceeded 300,000. Altogether, there are 29 different types of workers in the list. The cotton semi-skilled operatives head the entire list with the biggest gain; this is followed in turn by the food industry laborers, with a gain of 94 per cent. and the managers and superintendents in manufacturing establishments with a gain of 93 per cent. At the foot of the list with a loss of 47 per cent. are dressmakers and seamstresses; then come the general building laborers tabulated above, then the clay, glass and stone laborers with a loss of 19 per cent. and the brick and stone masons with a loss of 18 per cent.

Transportation

TABLE XI

Subheadings of transportation group	Loss or gain per cent.	1920 totals
Garage keepers and managers	+ 740	42,151
Chauffeurs	+ 535	285,045
Telephone operators	+ 94	190,160
Switchmen, flagmen, yardmen	+ 23	111,565
Brakemen	+ 23	114,107
Locomotive engineers	+ 14	109,899
Laborers, steam and street railways	— 13	495,713
Hostlers and stable hands	— 70	18,976
Livery stable keepers and managers	— 70	11,240
Carriage and hack drivers	— 76	9,057

In this table the substitution of the automobile for the horse is indicated, and the allied occupations have moved in keeping with the general trend. In the 1900 census, the automobile did not appear as a source of occupation; in 1910 there were 45,785 chauffeurs and 35,376 carriage and hack drivers. This change in transportation, which is of course very evident, has occurred with great suddenness; and in addition the spread of the automobile is much more extensive than that of the horse-drawn vehicle ever was.

TRADE

TABLE XII

Subheadings of trade group	Loss or gain per cent.	1920 totals
Laborers in coal and lumber yards, warehouses, etc.	+ 54	125,609
Bankers, brokers and money lenders	+ 52	161,613
Insurance agents and officials	+ 37	134,978
Laborers, porters and helpers in stores	+ 22	125,007
Salesmen and saleswomen	+ 20	1,177,494
Real estate agents and officials	+ 18	149,135
Retail dealers	+ 11	1,328,275
Clerks in stores	+ 7	413,918
Deliverymen	— 26	170,235

This is the nearest normal of any group listed. The entire group has had an increase of 16 per cent., which is about the average increase expected. The excesses in this group are less than in any other. The loss in deliverymen between 1910 and 1920 is indicated in a footnote of the census report as probably due to the substitution of motor for horse-drawn delivery wagons.

PUBLIC SERVICE (not otherwise classified)

TABLE XIII

Subheadings of public service group	Loss or gain per cent.	1920 totals
Soldiers, sailors and marines	+ 192	225,503
Other pursuits; life-savers, lighthouse keepers, etc.	+ 108	21,453
Laborers (public service)	+ 57	106,915
Officials and inspectors	+ 51	80,334
Firemen—fire department	+ 42	50,771
Marshals, sheriffs, detectives	+ 36	32,214
Guards, watchmen and doorkeepers	+ 35	115,553
Policemen	+ 32	82,120
Officials and inspectors (city and county)	+ 6	55,597

The increase of 192 per cent. in soldiers, sailors and marines is easily accepted as a war hold-over. The gain of 108 per cent. in other pursuits, of which life-savers and lighthouse keepers are mentioned, is somewhat misleading. Life-savers, which form only 2,287 of the group, increase less than 6 per cent., and lighthouse keepers (1,463) suffered a loss of about 4 per cent. The gain was the result of "other pursuits" and is not specified.

PROFESSIONAL SERVICE

TABLE XIV

Subheadings of professional service group	Loss or gain per cent.	1920 totals
Trained nurses	+ 82	149,128
Semi-professional pursuits (notaries, healers, welfare workers, etc.)	+ 79	116,555
Technical engineers	+ 54	136,121
Teachers	+ 27	761,766
Clergymen	+ 8	127,270
Lawyers, judges, etc.	+ 7	122,519
Physicians and surgeons	0	150,007
Musicians and teachers of music	— 7	130,265

It is probable that the increase in trained nurses is a war resultant; possibly the larger call arising from the widespread epidemics of influenza, the increased wages resulting from the scarcity of nurses during and directly subsequent to the war, and the change in the hours or working day for nurses. The increase in the so-called semi-professional pursuits is due in large measure to the welfare worker class, which numbers 41,078 of the total given for this sub-group and which increased in ten years by about 150 per cent. During the war there was a great shortage of teachers, and daily it was reported that schools had to be closed because there were no teachers available. The loss sustained at that time must have very quickly righted itself, because in January, 1920, the gain over 1910 is given as 27 per cent. This gain is a little above the average gain for all pursuits and about the average gain for this group.

Domestic and Personal Service

TABLE XV

Subheadings of the domestic and personal service group	Gains or losses per cent.	1920 totals
Elevator tenders	+60	40,713
Janitors and sextons	+58	178,623
Billiard room, dance hall, etc., keepers	+50	24,897
Restaurant and lunch room keepers	+40	87,987
Waiters	+22	228,985
Housekeepers and stewards	+17	221,612
Midwives and nurses (not trained)	+16	156,769
Barbers, hair dressers, manicurists	+10	216,211
Porters (except in stores)	+ 5	88,168
Boarding and lodging house keepers	—20	133,392
Servants	—20	1,270,946
Launderers and laundresses (not in laundries)	—21	396,756
Laundry, owners and officials	—31	13,692
Laborers (domestic and personal service)	—38	32,893
Bartenders	—64	26,085
Saloon keepers	—75	17,835

In general this group suffered a loss of 10 per cent. during the period. The gains above 20 per cent. show an extension of certain types of occupations which are characteristic of the times. The losses in this group are interesting; first, the loss in domestic service which arose rapidly following the war and which reflects probably the idea of servant as contrary to a liberty-loving people, and the losses sustained because of the prohibition amendment to the constitution.

Clerks in this table refer to shipping clerks, weighers and the like. Agents, canvassers and collectors are given an increase of 68 per cent., but this is made up of an increase of 156 per cent. in agents, with decreases in the numbers of canvassers and collectors. The interesting part of the table refers to accountants, which is

CLERICAL OCCUPATIONS
TABLE XVI

Subheadings of the clerical occupation group	Gains and losses per cent.	1920 totals
Clerks (except clerks in stores)	+ 109	1,487,905
Agents, canvassers and collectors	+ 68	175,722
Stenographers and typists	+ 66	615,154
Bookkeepers, cashiers and accountants	+ 50	734,688
Messengers, bundle and office boys and girls	+ 4	113,022

relatively a new occupation or better an old occupation with a great increase of business because of statutory demands. Accountants and auditors increased in the 10 year period to 201 per cent.

THE LOCALIZATION OF THE MEDIAN PLANE OF THE EMBRYO[1]

By Professor T. H. MORGAN

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THE eggs of many animals appear under the microscope to be radially symmetrical around a primary axis. This axis is an imaginary line extending from that region on the surface at which the polar bodies are given off (pole) through the center of the egg to the opposite pole (antipole). Sometimes the pole is indicated by the distribution of pigment or by some structure at the surface. The materials of the egg are stratified or graded from the pole to the antipole.

Other eggs have a bilateral structure. These eggs are always inclosed in a thick coat or cuticle (insects, squid). The median plane of the embryo corresponds to the plane of symmetry of the egg, but whether an innate bilateral structure of the protoplasm has determined the bilateral shape of the egg, and hence that of its coat also, or whether the shape of the egg coat, determined by the parent, gives shape to the enclosed protoplasm, has never been satisfactorily determined. It is true that many references could be gathered from the literature to show that embryologists have not hesitated to assume at times that there is present in all eggs, before fertilization, a real bilaterality whether they show it or not in their external form. Many statements could be cited that seem to mean that a bilateral structure (or "principle") exists in the egg cytoplasm which is the determining factor in locating not only the first planes of cleavage, but also the plane of bilaterality of the embryo. But how such bilaterality could direct or determine the position of cleavage furrows has never been explained, nor has it ever been made clear how such a postulated bilateral structure, were it present in the egg, could bring about the later differentiation with reference to a median plane.

It has been shown that the early divisions of the egg may sometimes bear a definite relation to the planes of symmetry of the embryo. It is, therefore, necessary to examine thoroughly the evidence that bears on this relation in order to find out whether the location of the cleavage planes determines the position of the embryo on the egg, or whether its position is independent of the cleavage.

[1] Chapters from Experimental Embryology. II.

The Relation of the Cleavage Planes to the Axes of the Embryo

The earliest observation showing the coincidence between the first plane of cleavage and the median plane of the body of the embryo was that of Newport in 1851. The position of the first cleavage in a frog's egg was recorded. The egg was left undisturbed until the neural folds appeared. Newport found that the median line between the folds corresponded with the mark indicating where the first cleavage plane had been. This observation has been repeated by at least ten later observers, who have, on the whole, confirmed Newport's observation. This relation can be determined only if the egg remains entirely undisturbed during the 40 to 60 hours between the first cleavage and the appearance of the neural folds. As a matter of fact, the egg does not remain stationary throughout this time, for during gastrulation the center of gravity of the embryo shifts so that the egg rotates. If, however, as appears to be the case, the egg rotates in the plane of the first cleavage, the original orientation may still hold, but if there are any irregularities in the process of gastrulation, these might cause the embryo to shift out of line. When the neural folds have been distinctly outlined, the embryo develops cilia over its surface that cause it to rotate within its membrane, and from this time onwards, there is ample opportunity for a change in position. The record of the position of the median plane must be made, therefore, as soon as possible. When all these precautions have been taken, it is found that there are still exceptional cases in which the two planes in question do not coincide. This was first observed by Roux ('83), then by Schultze ('99), Hertwig ('94), Morgan and Tsuda ('94), Kopsch ('95), Brachet ('04). The later observations have shown that when the first plane of cleavage does not cut through the middle of the gray crescent (see below), the median plane of the embryo corresponds with the crescent rather than with the first cleavage plane. The experiment of Brachet in which one of the first two blastomeres was injured, in cases where the first plane of cleavage did not coincide with the median plane of the crescent, confirmed this conclusion. It appears, therefore, that it is not the first cleavage itself that introduces a bilateral basis for the later development, but, on the contrary, the bilaterality of the frog's egg is already determined by the median line of the gray crescent that appears soon after fertilization and before the first cleavage appears. Therefore the question of fundamental importance is to determine what factor in the egg of the frog is responsible for the appearance of the gray crescent on one side of the

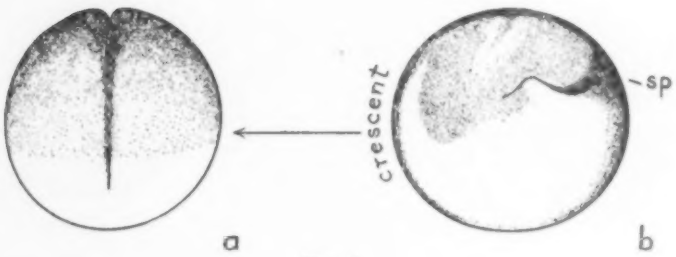


FIG. 1.

egg (Fig. 1, b). There is still the problem as to why the first plane of cleavage generally cuts through the middle of the crescent (Fig. 1, a), but for our present purpose this is a question of secondary importance. Before discussing further these problems in the frog's egg, the relation of the first cleavage plane to the median plane in other eggs may be examined.

In the salamander, *Diemyctylus viridescens,* the second cleavage corresponds to the median plane of the embryo according to Jordan's ('93) observations. A similar relation was found by Spemann ('01) to be the rule at least for the European salamander (Triton). In neither case has a gray crescent been observed, although it is possible that a change, similar to that which produces it, may take place but not be visible on the surface. By tying a

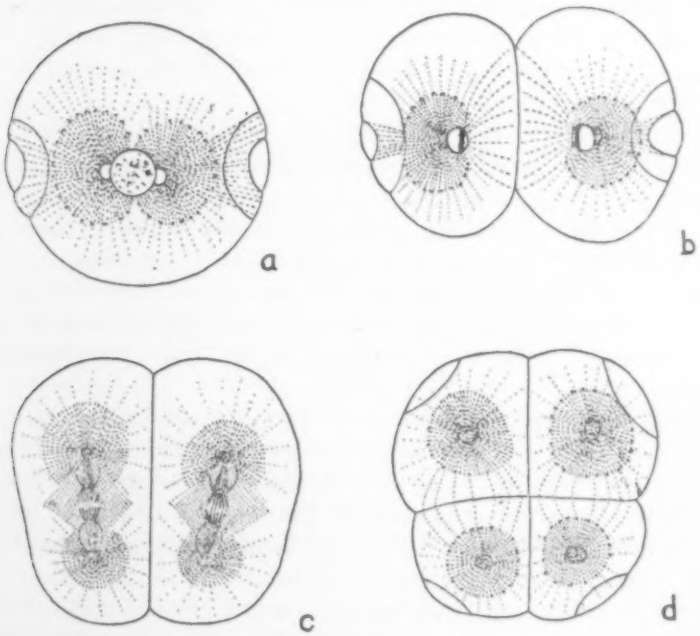


FIG. 2.

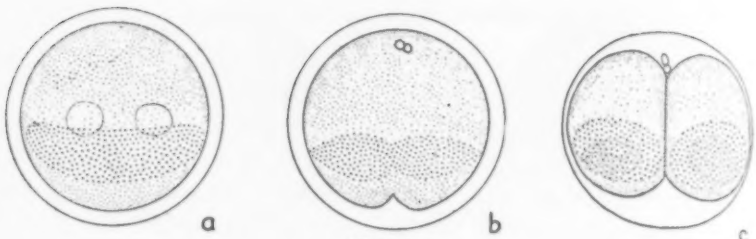


FIG. 3.

ligature around the egg at the time of the second cleavage and in that plane, Spemann found that double headed embryos can often be produced, owing to the partial splitting of the material into two parts. By further constriction, two whole embryos result which is not, as a rule, the case when the egg of the salamander is constricted in the first plane of cleavage. The result furnishes experimental evidence that, in this case, it is the second cleavage, and not the first that usually corresponds to the median plane of the embryo.

In 1884 Van Beneden and Julin published a detailed account of the cleavage of the egg of the ascidian Clavelina (Fig. 2). They observed that the first plane of cleavage coincides with the later median plane of the embryo. Chabry ('87), Seeliger ('85), Castle ('94) and Conklin ('05) have confirmed this relation for the eggs of other ascidians. Conklin has found in another ascidian Styella that immediately following fertilization a crescentic shaped accumulation of yellow pigment appears on one side of the egg (Fig. 3, a). The first cleavage (Fig. 3, b, c) passes through the middle of the yellow crescent.

The cleavage of the ascidian's egg takes place with almost no variation in the position of the successive planes of division and in the sizes of the resulting cells. In this respect it differs from the frog's egg, in which there is much variation, especially after the third cleavage. Since there are no sufficient observations as to the results that take place when the first cleavage of the ascidian fails to coincide with the crescent, we have no means of deciding whether the crescent or the cleavage plane is the basis for subsequent bilaterality.

Finally, it has been shown by Clapp ('91) and by Morgan ('93) that there is no definite relation between the first or second plane of cleavage of the fish's egg (Fig. 4, b, c), and the median plane of the body. Miss Clapp determined this for the large fixed egg of the toad fish and Morgan for the small pelagic egg of Ctenolabrus, and the somewhat larger eggs of Fundulus. The floating pelagic eggs seem to be perfectly spherical, nor is there any plane of symmetry visible in the other larger fish eggs. What factor or factors

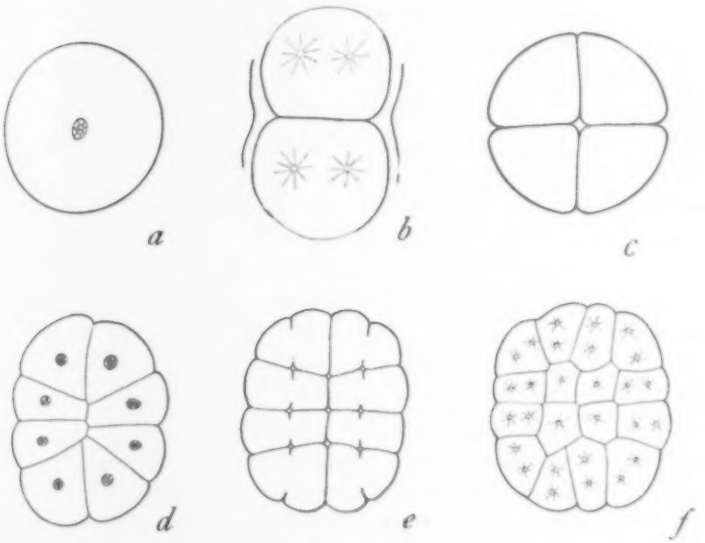


FIG. 4.

determine the median plane of the embryo is entirely unknown. The two-, four-, and eight-cell discs (Fig. 4, b, c, d) are at times bilateral in different planes, but this is apparently without significance for the later embryo. The many-celled disc of later stages appears to be again radially symmetrical.

EGGS WITH BILATERAL SYMMETRY BEFORE FERTILIZATION

In addition to the cases in which the egg before fertilization appears to be radially symmetrical around its primary axis, there are other cases in which the egg has already a plane of symmetry when it is fully formed. In these, the median plane of the embryo corresponds with the plane of symmetry of the egg. For instance, the egg of the squid has, according to Watase ('91), a strictly bilat-

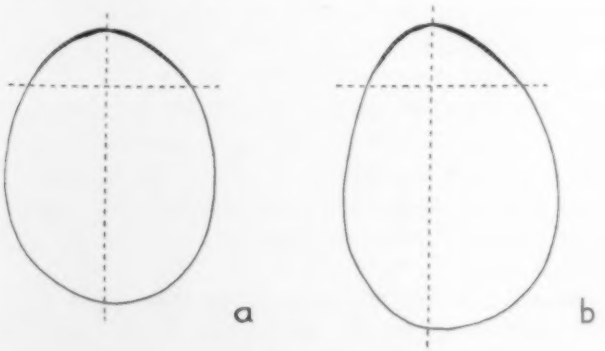


FIG. 5.

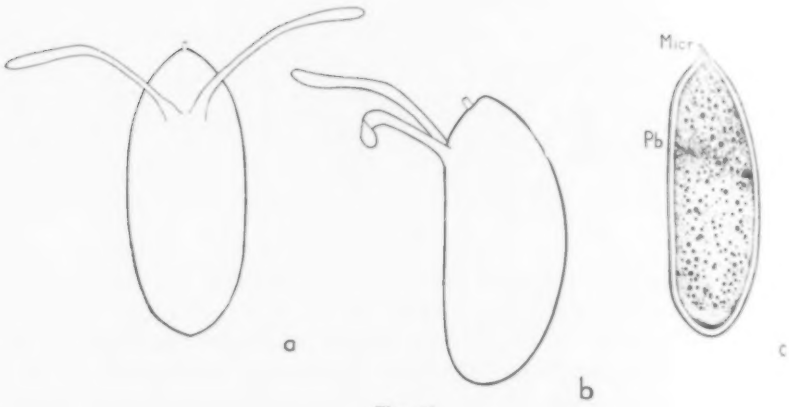


FIG. 6.

eral structure (Fig. 5, a, b). The first division is in this plane as is later the median plane of the embryo. It has not been shown whether the shape of the squid's egg is determined, in the first instance, by the shape of the follicle which surrounds it or whether it is determined by the protoplasm of the egg itself. It is also not known whether the first spindle places itself across this plane of symmetry, preparatory to the first division, in response to the shape of the egg, or whether other factors determine its position. Experimental evidence is lacking.

The eggs of many insects have a marked bilateral form (Fig. 6, a, b) which, in a way, corresponds with that of the mother's body. The anterior end of the insect's egg is not the point of the surface at which the polar bodies are given off. These lie anteriorly, but on the dorsal side of the egg at a point generally not very far from the micropyle of the egg through which the spermatozoa enter (Fig. 6, c, at Pb). The plane of bilaterality of the embryo corresponds with that of the egg.

The cleavage of the insect egg is centrolecithal, that is, the segmentation nucleus first divides into two nuclei and the daughter nuclei later divide again and again, but the protoplasm of the surface of the egg does not split up at this time. Only when a large number of nuclei have appeared, and have reached the surface, does the layer of protoplasm that covers the egg become constricted around these nuclei into a large number of cells. The bilaterality of the embryo proper can become apparent only when the embryonic organs develop out of this surface layer.

THE ORIGIN OF BILATERALITY IN EGGS THAT ARE RADIALLY SYMMETRICAL

From the preceding considerations it is evident that, in eggs

that have, before fertilization, a bilateral form, there is at present no way of deciding whether the shape is due to an inherent property of the protoplasm, or is imposed on the protoplasm by the maternal cells that produce the egg-shell. On the other hand, in eggs that are radially symmetrical around the primary axes before fertilization, there is evidence to show that bilaterality is introduced at the time of fertilization. It has been shown, for example, by Wilson and Matthews ('95), in the egg of the sea urchin, that the spermatozoon may enter at any point of the surface, and that its entrance determines the plane of the first cleavage, and since the bilaterality of the embryo coincides with the cleavage planes, it follows that the bilaterality is induced from the outside. In Nereis it has been shown by Just ('12) that the first cleavage cuts through the point of entrance of the spermatozoon and since the bilaterality of the embryo of Nereis has a definite relation to the cleavages, it follows here also that the bilaterality is superimposed from outside on a radial form. In the frog's egg it has also been shown by Roux ('83), Brachet ('03) and Jenkinson ('09) that the path of entrance of the spermatozoon coincides with the plane of bilaterality of the gray crescent (Fig. 1, b), and that this plane is also the plane of bilateral symmetry of the embryo. The gray crescent is not present in the unfertilized egg, but appears about an hour and a half after the sperm has entered.

These relations leave scarcely a doubt but that in these eggs—and they are typical of their kind—the bilaterality is induced from outside. I am inclined to think that this is also probable in the case of those eggs where the shell imposes on them from outside a bilateral form, although this is only an inference and has not yet been demonstrated by experiment or observation.

There are two further sources of evidence that relate to the origin of bilaterality in the frog's egg: (1) the origin of the gray crescent in eggs fertilized by two or more spermatozoa, and (2) the location of the crescent in parthenogenetic eggs. The former relation has been studied by Herlant ('11). If the unfertilized eggs of the frog are taken from the uterus and placed in concentrated sperm, many of the eggs are entered by two or more sperm. These sperm always enter in the black hemisphere apparently at any point. In dispermic eggs the gray crescent appears at the normal time and always between the two points of entrance of the spermatozoa, as shown in Fig 7. Hence, as in the normal egg, there is a definite relation between the points of penetration and the gray crescent, and the result is, in a sense, a compromise between the two influences acting at the same time. Whether a normal embryo results depends on special conditions relating to the division of the

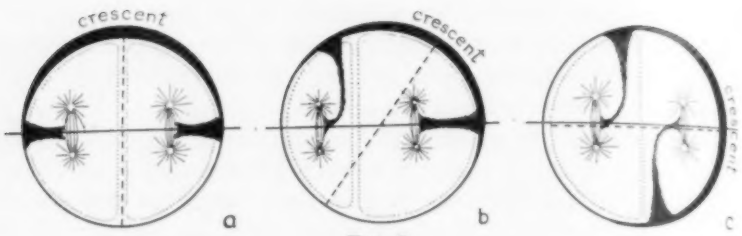


FIG. 7.

nuclei, but when an embryo does develop it stands in the same relation to the crescent as does the normal embryo.

When more than two spermatozoa enter an egg a single crescent also develops, but Herlant could not make out any relation between it and the entering points of the spermatozoa. Yet, in the light of the other evidence, it seems to me more probable that there is such a relation, rather than that, under these circumstances, the position of the crescent is predetermined in the egg structure itself, as Herlant suggests.

The origin of bilaterality in the parthenogenetic egg of the frog has been examined by Brachet. The development was started by Bataillon's method of puncturing the egg with a fine needle. In all eggs so punctured the gray crescent appears as in normally fertilized eggs, but *it has no definite relation to the point of puncture.* Only a small percentage of such eggs show a regular cleavage, and a still smaller percentage develop into embryos. In those that do, Brachet found that the embryo develops in relation to the crescent. He interprets the result to mean that the egg has a sort of labile bilaterality that may express itself in the egg alone, but which in normal fertilization may be altered into a new bilaterality by the entrance of the spermatozoon. In this respect he agrees, to some extent at least, with the older conclusion of Schultze, that the unfertilized frog's egg has an inherent bilateral structure; but Schultze also thought that it is not changed by the entrance of the spermatozoon. Personally, I do not think that one is obliged to draw the conclusion from Brachet's results that he has drawn. On the contrary, I am more inclined to think that the formation of the crescent in the parthenogenetic egg may have some definite relation to the internal changes connected with the development of the artificially induced cytasters that produce the mitotic figure for the first cleavage. Herlant ('13) has studied the origin of these cytasters and has shown that two or more develop in or near the path of entrance of the needle. Two of them, under optimum conditions, form the poles of the cleavage spindle. Their passage to the region of the egg nucleus may possibly induce the interior changes that

locate the crescent. It is true that this can not be shown to be the case at present, but in the light of the other evidence relating to the origin of bilaterality in the frog's egg, I am inclined not to ignore, at least, such a possibility.

The Position of the Chick in the Egg

The determination of the median plane of the embryo of the hen's egg, and the position of the embryo with respect to the shape of this egg has aroused a great deal of interest and speculation.

It has long been known that the young embryo chick lies, in most cases, across the long axis of the oval-shaped shell. If the large end of the shell is held to the left and the shell opened, the embryo is found on the upper surface of the yolk, with its head away from the observer in a great majority of cases (Fig. 8). The discovery of this relation goes back at least as far as von Baer (1828) and was probably known before his time, according to Bartelmez ('12, '18). The yolk on which the embryo lies is not spherical according to Bartelmez. Its longest axis corresponds with that of the shell. Its primary axis, extending from the embryo "downwards" through the center of the egg, is the shortest axis; while the axis in the third dimension ("horizontal") is intermediate in length. The yolk is surrounded by the spirally wound concentric layers of albumen, or "white," that have been formed as a secretion from the walls of the oviduct as the egg has passed down its length. The pointed end of the future "egg" is in advance, as the egg passes down the oviduct in a spiral path. This end may therefore be called the cloacal end and corresponds approximately to the right side of the later embryo. When the egg enters the oviduct it receives first the cloacal chalaza and then the opposite chalaza; these are fastened to the vitelline membranes and hold the egg in position, except in so

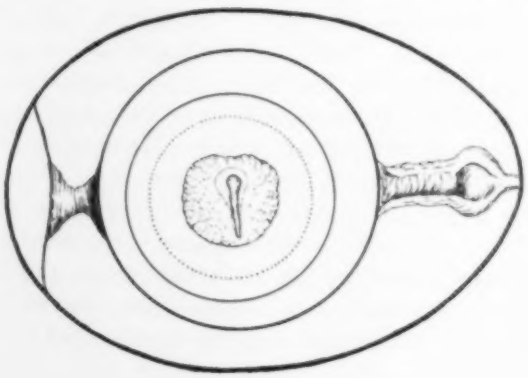


Fig. 8.

far as it rotates, as it progresses on the axis connecting the chalazae —the future long axis of the yolk. In other words, the egg keeps its pole always against the wall of the oviduct and the path of the pole inscribes, as it were, a spiral path on the wall of the oviduct.

It may appear that the shape of the yolk is due to the compressing layers of albumen which in turn are compressed by the hard shell. If this is the case the position of the embryo across the long axis might be supposed to be due to the shape of the egg, but this hypothesis alone fails to explain why the head is nearly always turned towards the same side of the egg. Since the two ends of the egg are of different shapes, one broad (where the air space comes to lie), and one pointed, it might appear at first sight that the resulting pressure relations might account for the orientation of the embryo on the egg, but again this suggestion will not explain why the head is nearly always directed towards a particular side.

Bartelmez, who has studied the egg of the pigeon in great detail, where the axial relations are the same as in the hen's egg, believes that the egg is bilateral before it enters the oviduct, and that one particular side of the egg enters first and this accounts for the orientation of the egg in the oviduct,[1] and also for the position of the embryo on the egg. In other words, he thinks that the ovarian egg has both a bilateral structure as well as a primary axis at right angles to this structure. His study of the early eggs, even before the yolk is laid down, led him to conclude that this bilaterality is expressed both in the excentric position of the nucleus (in regard to the primary axis) and in the elongation of the egg in one axis that corresponds to that seen in the oviducal egg, but the chances of error in such a determination must be very great.

The egg in the ovary is enclosed in a follicle that projects from the surface of the ovary as the egg enlarges. Its walls then develop a rich supply of anastomosing blood vessels, except over a crescent-shaped line, where the outer and inner layers of the follicles are fused with each other. This non-vascular crescent is known as the stigma, and according to Bartelmez the stigma lies nearly in the long axis of the egg. It develops, however, at a later stage than the supposed bilaterality of the egg, and he thinks follows it. According to Bartelmez a bilaterality is present even in the very tiny ovarian egg.

On this view it is, of course, necessary for consistency, to suppose that at the time when the egg breaks out of the follicle to be swallowed by the enveloping infundibular funnel, one of its ends enters first, as stated above, and the method of breaking of

[1] Something more than bilaterality is required to explain why the right side rather than the left should be the first to enter the oviduct.

the stigma is supposed to be of such a kind as to bring this about, or else the materials of the ends must be supposed to be of such a sort that one end is more likely to enter than the other. Floating ovarian eggs, freed from the follicle, give evidence, Bartelmez thinks, that there is a difference in the specific gravity of the two ends in question. His account is so detailed and positive that it might appear to settle the question for the bird's egg; but on the other hand, it may be pointed out that the evidence relating to the very young eggs is by no means as certain as the importance of the situation demands. It is, moreover, difficult to obtain accurate evidence of this kind. The considerable variation in the position of the embryo with regard to the long axis of the egg on which the author lays such emphasis indicates either that the early bilaterality of the egg bears a very variable position to the axis of the embryo, or else that there is much variation in the way the egg enters the oviduct and passes down its length, which is not in full harmony with the interpretation of the process as described as taking place. In the rare cases where the head of the embryo is turned in the reverse direction Bartelmez assumes that the wrong side of the egg has, perchance, entered the oviduct first.

The axes of the chick embryo are already determined in the oviduct before the shell is laid down, since gastrulation takes place in the oviduct. The pressure of the oviduct on the two ends of the egg that determines the shape of the albumen would give, theoretically, an explanation of one of the factors involved, namely, the position of the embryo across the long axis of the egg. It remains still to be shown why the head of the embryo lies on a specific side of the yolk. The following suggestion may furnish a clue. If the position taken by the egg on entering the oviduct is due to differences in compressibility of the egg of such a sort that it is more easily compressed in its primary axis (due to the distribution of the concentric rings of yolk); and if the advancing and the following ends of the egg are under somewhat different conditions (due to the contraction behind and the relaxation of the tube in front that allows the egg to advance); and if the spiral path taken by the egg in its passage down the tube is due to the structure of the oviduct; and if the spiral is, as a rule, a right- (or left-) handed spiral (as shown by the albumen), then the conditions are such that one side of the blastodisc is subjected to different influences from the opposite side. If this affects the position of the embryo, either directly or indirectly, in somewhat the same way as the bilateral antero-posterior shape of the egg-case in many insects may be supposed to determine the orientation of the embryo, there is a formal explanation of the orientation of the chick. Further observations are needed to settle the truth or falsity of this hypothesis.

THE PROGRESS OF SCIENCE

By Dr. EDWIN E. SLOSSON
SCIENCE SERVICE, WASHINGTON

SCIENCE AND PSEUDO-SCIENCE

MODERN complex industrial life plunges every one into a scientific environment so that no one can escape the deluge of scientific terms. But he may get them wrong. Each new discovery starts a parasitic growth of pseudo-science.

There *is* a north pole; but Cook didn't discover it.

There *is* magnetism; but not "animal magnetism."

There *is* wireless telegraphy; but that does not prove telepathy.

There *are* electrons; but "electronic" cures do not follow.

From miscellaneous reading in the papers the average layman gets a confused, composite, half-digested impression to the effect that "Science says":

People are descended from "monkeys"; the sun is made of radium; Mars is inhabited by a race of canal diggers; the ancient Mayas knew all about relativity; the earth is getting hotter; the earth is getting colder; the earth will be smashed up by running into a comet; the average mental age of Americans is thirteen; all progress comes from a superior Nordic race; mankind is losing all its teeth and hair; the world is going to starve to death from overpopulation; the world is going to die off from race suicide; Conan Doyle proved the existence of fairies; drinking sour milk or grafting goat glands will make everybody live to 150; there is no soul; everybody has two or three souls; according to Freud you must give rein to every impulse or die of a complex; all rheumatism comes from bad teeth; all diseases can be cured by manipulating the backbone; harnessing the power of the tides will replace coal as a source of power, etc., etc.

Some of these notions are false, some are hypotheses which may or may not be true, some are truths badly expressed or placed in a misleading context. The result is that the layman either becomes sceptical of all science or credulously falls victim to the first faker that can manipulate imposing catchwords.

Not only do new superstitions crop up from the soil fertilized by genuine discovery, but the old weeds still linger. Dream books, not only those based on Freud, but others of the old traditional sort, still sell in the shops. Fortune tellers manipulate packs of cards as well as Ouija boards. Astrology numbers more followers than lived in Egypt, Chaldea and Rome. We are only two hundred years removed from witch-burning forefathers, and some would do it yet if the law permitted. An excited fundamentalist in a Southern paper demands that all evolutionists be crucified head down.

This is not all cause for pessimism. At least it shows that science attracts great interest and has vast prestige. "Imitation is the sincerest form of flattery." If fifty years ago legislatures did not persecute Darwinism it is because the average legislator had never heard of it. If people talk nonsense about Freudianism, hypnotism, Einstein, psychological tests, vitamins and the like, at least they have heard of these things and want to

—Wide World Photos

MADAME CURIE

The twenty-fifth anniversary of the discovery of radium by Pierre Curie and Madame Curie has been celebrated at Paris with suitable ceremonies. The French Chamber of Deputies has voted a special pension to Madame Curie and to her children.

—*Wide World Photos*

DR. ROBERT ANDREWS MILLIKAN

Director of the Norman Bridge Laboratory of Physics and chairman of the Administrative Council of the California Institute of Technology, to whom the Nobel Prize in physics has been awarded.

hear more about them. All they need is some clue as to what things are so and what things are not.

Unfortunately those who trade on the name of science for profit, or who are fanatically sincere about some absurd theory, are better advertisers than the real scientists. They make more noise, assert themselves more dogmatically, make more sweeping claims and get attention first. They are not handicapped by the hesitations, uncertainties, shyness, professional caution of the true man of science. Reservations and qualifications make dull reading, and the necessary complexities of the scientific vocabulary frighten away the casual reader. Moreover, it is to be feared that some scientists are intellectual snobs and do not care whether the layman understands or not. They leave the field to pseudo-science without a struggle.

On the other hand, in the long run real science prevails over what the Bible terms "science falsely so-called" because it can prove itself by its works. "By their fruits ye shall know them," the experimental method. Only real chemistry can provide the basis for the big industrial inventions which the public demands and appreciates. Only real medicine can in the long run lower the municipal death rate.

There is another test of real science; its honesty. Fake science always tries to create mystery, to use long words for the purpose of creating confusion, to rely on occult forces and secret processes, because only so can it remain a profitable monopoly. Real science relies on tests and experiments that any one can duplicate and does not add artificial difficulties to the real mysteries of nature. In a word, the real scientist and the faker are both talking to the layman in unknown tongues, but the real scientist is trying to make himself understood, the faker is trying to make himself misunderstood.

HOW WOMEN CONTROL THE FUTURE

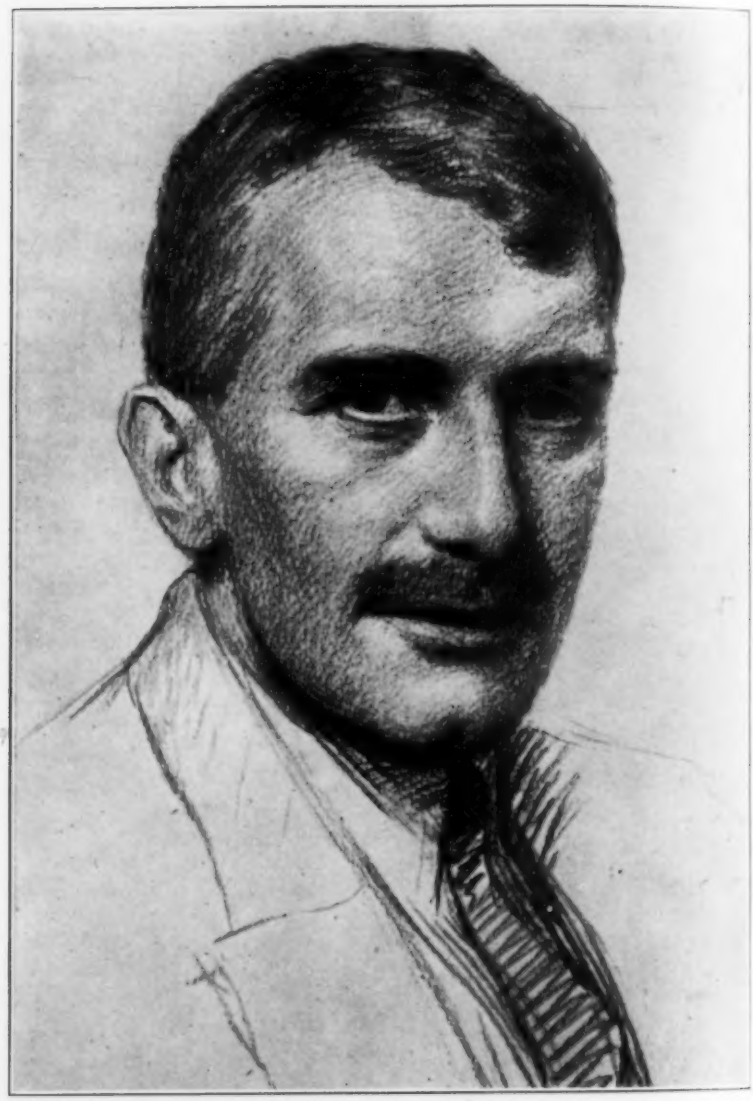
WOMAN'S sphere has become greatly enlarged in recent years. It is considerably larger than it used to be and vastly larger than it used to be thought. I do not allude to the political enfranchisement of women—this was merely an act of justice and will doubtless prove beneficial, but it is insignificant in comparison with what I have in mind, that is, woman's power over the rising generation through her share in inheritance and her control of early training.

There are two kinds of inheritance, the internal and the external:

First, the physical inheritance, the constitutional transmission of bodily and mental characteristics and capabilities.

Second, the cultural inheritance, by which language, institutions and laws, science, art and ethics, are handed down from one generation to the next, and the training by which character is molded and set.

Now in the first, the bodily heredity, women have an equal part. They have always had it, of course, but this was not known until demonstrated in recent laboratory experiments. It was formerly thought the masculine element predominated in heredity; that the law of primogeniture held in the physiological as in the legal world; that traits are handed down with the father's name. Genealogists traced up the line of names and since the mother's name was dropped her hereditary bequest was supposed to be slight and soon eliminated. But the Salic law does not hold in nature. Modern science has revealed two facts in regard to heredity that put the



PROFESSOR A. V. HILL

Appointed to the Jodrell Chair of Physiology in the University of London this year, and joint winner with Professor Meyerhof, of Kiel, of the Nobel Prize in physiology. From a pencil drawing, from life, by F. W. Schmidt, Manchester.

position of woman in quite a new light. First, that the mother's share is exactly the same as the father's in the transmission of characteristics to their offspring, and, second, that such inheritance is vastly more important than we formerly supposed. In short, that nature is more powerful than nurture, and that a person's capabilities are strictly limited and largely determined by his endowment at birth.

This equal share in fixing the character of the coming generation is settled upon woman by the Creator and she can not alter or escape it except by evading maternal duties altogether. Nor can she improve upon her present practice except by exercising greater care in the selection of a husband, and there she is limited by having such a poor lot to choose from.

It is otherwise in regard to the second kind of inheritance, the external or cultural. Here woman's part has become recognized as larger and has become actually enlarged. Women have always had the care of children from infancy mostly in their hands, either as mothers, nurses or kindergartners. This task was left to the women because it was bothersome and was not thought to amount to much. If the children got the proper amount of calories and vitamins and had their muscles exercised at proper intervals, nothing else mattered much. We can all remember when certain reformers advocated putting babies in big orphan asylums where they could be cared for by wholesale and presumably more efficiently. But now we know better, for modern psychology has shown that our morals and temperaments are largely molded by the influences of infancy, that the fears and the affections of the nursery may haunt one through life, that cradle songs and childish jokes may make or mar a man's career. It has long been recognized that in religious training the first seven years of life are the most important.

If you have watched the making of a concrete building you know that there are two critical points in the process:

First, the composition of the concrete, the quality of the ingredients and how they are mixed.

Second, the settling of the concrete, how it is poured, compacted and distributed and settled. The first hour after pouring determines once for all how well the building will stand. Afterwards nothing can be done to improve the mass of concrete except to chip it into shape and give it a superficial polish and tint.

So it is with human beings. The two things that most determine character and destiny are natural endowment and childhood training. Now women control 50 per cent. of the natural endowment and some 75 per cent. of the childhood training. More than that, they have, through taking up the teaching profession, gained control of most of the formal education of both boys and girls up to the age of adolescence. At seventeen years in most cases, and often earlier, one has all the native intelligence he ever can have and what he learns later is how to use it. His character is by this time so solidly set that neither he nor any one else can do much to change it.

So through natural endowment and modern custom women have come to have control of a majority of the formative influences of successive generations, some 60 to 70 per cent., depending on how you count the earlier character-forming years. Even in that form of cultural heredity where the chromosomes are words, that is, literature, women are taking an increasing part, for they now write a large proportion of our books and periodicals.

ASTRONOMICAL EVENTS IN 1924

BY ISABEL M. LEWIS

THE closest approach of Mars to the earth in at least a generation; a transit of Mercury across the sun's face, an event which will be repeated but three times this century; five eclipses; and occultations of Mercury, Neptune, Aldebaran and Regulus by the moon, are the leading special offerings of the heavens to star gazers in 1924. Three of the eclipses will be of the sun and two of the moon, but none of them will be visible in the United States.

By far the most interesting astronomical event of 1924 will be the near opposition of Mars next August. Every fifteen or seventeen years the opposition of Mars occurs when the planet is not far from perihelion or the point in its orbit nearest to the sun. The planet is then about 26,000,000 miles nearer to the earth than it is at its most distant opposition, which occurs when it is near aphelion or the point in its orbit farthest from the sun. The last close opposition of Mars occurred in September, 1909, when Mars came within 36,180,000 miles of the earth. On August 22 of this year, a few hours before it comes into opposition with the sun, Mars will be at a distance of 34,630,000 miles from the earth, which is very nearly, if not quite, as close as it can ever come to the earth, and about one and a half million miles nearer than it was fifteen years ago.

The coming opposition of Mars is being awaited with keen interest by all interested in the study of the surface markings of this sister world, which, next to the moon and Venus and an occasional asteroid or comet, comes nearer to us than any other member of the solar system.

Schiaparelli made his much-debated discovery of the "canals" of Mars at a close opposition, that of 1877, which he confirmed at the following favorable oppositions of 1879 and 1881. Every close opposition of this mysterious planet brings additional observations of special interest and value and it is practically certain that this, the closest of all, will be no exception.

Mercury will cross the face of the sun on May 7, the transit taking about eight hours from ingress at the eastern edge to egress at the western edge of the sun. In the United States only the ingress of the planet will be visible, the sun setting with Mercury on its disk. The entire transit will take place above the horizon in Alaska and the Philippines. The last transit of Mercury took place on November 6, 1914, and future transits will occur on November 12, 1940, May 9, 1970, and November 14, 1999.

The solar eclipses of 1924 will all be partial and the lunar eclipses will be total. The partial solar eclipse of March 5 will have a greatest magnitude of 58 per cent., and will be visible only in the Antarctic and South Atlantic oceans and the extreme southern part of Africa. The solar eclipse of July 31 will have a magnitude of 19 per cent., and will be visible only in south polar regions. The solar eclipse of August 29 with a greatest magnitude of 43 per cent. will be visible in the Arctic Ocean, Greenland, the northern part of Norway and Sweden, northern Russia, Siberia, northern China, Kamchatka and Japan.

The total eclipse of the moon of February 20 will be visible in the extreme northwestern part of North America, the Pacific Ocean, Australia, Asia, the Indian Ocean, Europe and Africa, except the extreme northwestern part.

The total eclipse of the moon of August 14 will be visible in the western part of the Pacific Ocean, Australia, Asia, the Indian Ocean, Europe, Africa, the Atlantic Ocean, and eastern and central South America.

Occultations of Aldebaran by the moon, visible in the United States, will occur on February 13, April 8, June 28 and September 18. The first-magnitude star Regulus, in Leo, will also be occulted on October 22, the planet Mercury on August 2 and Neptune on November 18. As Neptune is not visible to the naked eye its occultation by the moon can only be viewed telescopically.

THE SERVICE OF SCIENCE

"EVOLUTION can not be killed by legislative enactment," declared the retiring president of the American Association for the Advancement of Science, Professor J. Playfair McMurrich, of the University of Toronto, in a notable address which opened on December 27 the program of the seven day meeting of the association at Cincinnati. Professor McMurrich reviewed the progress in scientific thought in the seventy-five years since the association was founded and stated that the doctrine of evolution was the guiding clue through the flood of new knowledge, the stimulating idea without which much of scientific progress would never have been conceived. Doubts of its validity could only be based on ignorance or prejudice. Professor McMurrich continued:

> In the popular mind the doctrine of evolution is so completely involved in Darwin's exposition of it that it has come to be regarded as the product of his brain. Consequently any acknowledgment that some of Darwin's views may require modification is assumed to imply that the foundations of evolution are shaken. It seems trite to repeat once more the true relation of Darwin's theory to the doctrine of evolution, but there seems to be need for its repetition.
>
> Evolution as a theory long antedates Darwin's time; Laplace, to go on farther back, found it in the history of the heavenly bodies, Lyell demonstrated it in the history of the Earth, and Goethe, Buffon and Lamarck saw it in the history of terrestrial organisms. What Darwin did was to give a plausible and convincing explanation of how organic evolution might have occurred, but whether that explanation is or is not the correct one matters not so far as the doctrine of evolution is concerned; that stands unshaken even though Darwin's explanation of how it was brought about be discarded. The evidence in its favor to-day is many times stronger than it was in Darwin's time and it seems incredible that man as a reasoning animal should presume to doubt its validity.

The retiring president urged upon the association the duty of putting the results of researches into popular language for the benefit of those who have not had scientific training. He said:

> These form a not inconsiderable and important portion of our membership, they come to our meetings to hear something of the latest achievements of science and they listen to addresses largely in an unknown tongue. They ask for bread and are given a stone and profit little from such a monolithic repast. Yet these are the persons that we should endeavor to interest if we are truly and fully pledged to promote the advancement of science. Esoteric science may lead from discovery to discovery, but until the significance of its discoveries is made intelligible to what are termed the men in the street it fails to secure popular support. The unintelligible is mysterious, and mystery awakens either ridicule or dread.
>
> Much has been spoken and written concerning the need for a popularization of science and something has been done towards its accomplishment, notably the establishment of Science Service so ably edited by Dr. Slosson. But is not this very thing a prime duty of this association, devoted as it is to the advancement of science, and does the association live up to the full measure of its responsibilities in this matter?

Revolutionary changes in popular beliefs brought about by science are now looked upon without alarm, and this altered attitude was, in the opinion of the speaker, due to the many practical applications of science.

The distrust of seventy years ago has given way to trust and the world accepts with tranquility the shattering of many old beliefs, providing that the necessity for their destruction is vouched for by competent scientific opinion. The theory of relativity, whether or not its full significance is understood, is swallowed without a spasm, even though it may displace the theory of gravitation from what seemed to be its unassailable position; and that the atom, supposed to be the ultimate, indivisible abstraction of human thought, is in reality a more or less complex system of electrons revolving planet-like about a central nucleus, even this idea is accepted without a tremor.

This change of attitude is undoubtedly largely due to an increased appreciation of the value of science as shown by its practical applications. This may not have been the only factor, but it is a potent one. It is impossible to consider the multitudinous and marvellous facilities that have become parts of our daily life without realizing that they are but the practical applications of scientific principles to the control or utilization of natural forces and materials, without, in other words, perceiving that it is to scientific investigation that we are indebted for these advantages. The men who have made these practical applications become known and respected, their names become household words, they are the representatives and high-priests of science and their glory is reflected upon even the most abstruse fields of scientific investigation. The attitude assumed may be expressed thus: "See what great benefits science has conferred! It promises others and therefore it is to be encouraged."

For the present we must perhaps be satisfied with this. For several centuries science was under the ban, dogma was supreme and science, which necessarily found itself in contest with this, was impious and heretical. Truth was standardized and complete and to question that accepted truth was to undermine the foundations of belief. The human mind is conservative in its reactions; habits of thought are as difficult of modification as habits of action and the change from the dogmatic to the scientific habit has been slow; indeed, it is far from complete even now. The utilitarian appeal of science has done much to emancipate it from the thraldom to dogma, but it is not yet universally recognized that the utility of science depends absolutely upon its success in discovering truth. It is only by getting at the true facts and the true principles involved in any problem that the results of science become useful. The scientist is a searcher after truth and it is for that reason that he is able to confer benefits on humanity; it is for that reason that he deserves recognition. Surely he should feel no necessity for an apology for his existence.